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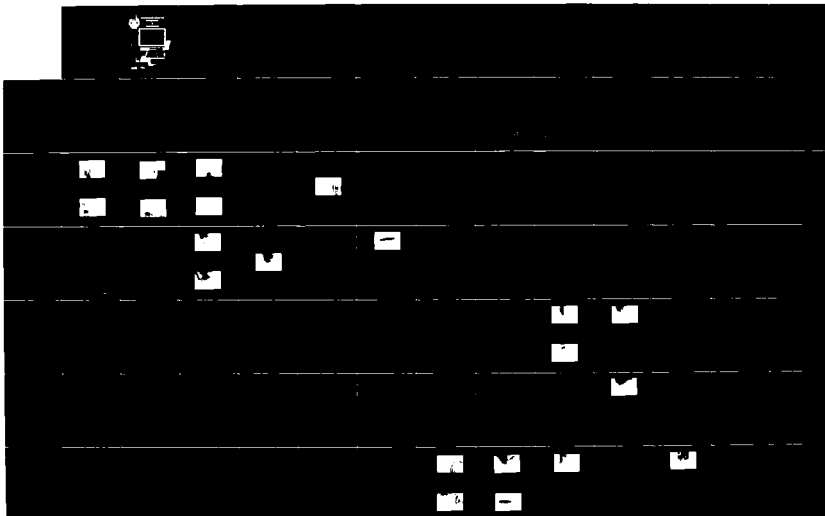
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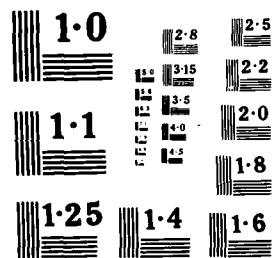
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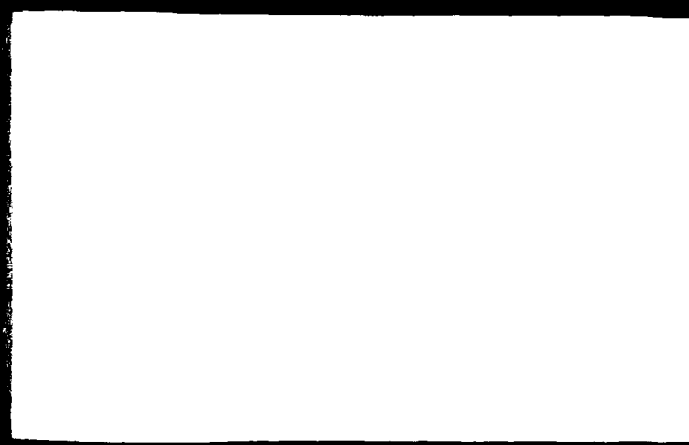


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**UNDERWATER FACILITIES
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ASSESSMENTS
AT**

PHILADELPHIA NAVAL SHIPYARD

PHILADELPHIA, PA

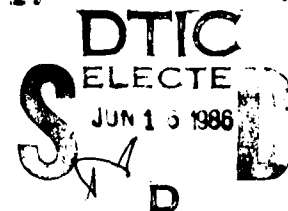
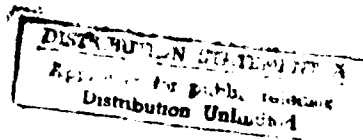
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FPO-1-83-(48) OCTOBER 1983

**PERFORMED FOR: OCEAN ENGINEERING AND CONSTRUCTION PROJECT OFFICE
CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C. 20374**

**UNDER: CONTRACT N62477-81-C-0448
TASK 7**

**BY: CHILDS ENGINEERING CORPORATION
MEDFIELD, MA**



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The inspected facilities covered in Volume III are Wharf F and Pier F, Wharf
E, Rowan Avenue Wharf, Second Street Wharf, Preble Avenue Wharf, Broad Street
Wharf, Wharf L and Wharf N..

Wharf F and Pier F are both in good condition. There are 124 bearing (Con't)

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piles which were found to be deficient. Generally the cause of these deficiencies can be attributed to berthing and mooring forces transmitted to the pile through the use of camels. These piles should be repaired. A slight crushing of the pile caps about the perimeter of the wharf and pier was noted. This condition is assumed to be caused by a weakening of the outer timber fibers (softness) and not overloading. At this time the softness is not a threat to the integrity of the structure. Live-loading on Wharf F and Pier F can be maintained at current levels (750 psf).

A partial collapse of the relieving platform of Wharf E has occurred. This collapse is a result of many forces acting in combination against the weakened (due to softness and eccentric loading) structural timber. Apparently, the imposition of a live-load on the top deck of the structure was the "straw that broke the camel's back". Live-loading on the structure from Bents 1 through 58 (newer construction) should remain at 200 psf. On the older structure, Bents 58 through 148, live-loading should be limited to 100 psf due to the timber softness found. In considering reconstruction of Wharf E, the extension of the Rowan Avenue steel sheet pile bulkhead would be the logical path to follow, particularly to increase the live-load capacity of the structure.

The Rowan Avenue Bulkhead has recently been rehabilitated with the construction of a new steel sheet pile bulkhead & soil anchor system. The steel sheet piles are in excellent condition with no significant metal loss. There have been problems involving sinkholes behind the steel sheet pile. The sinkholes are caused by the repositioning or settlement of the fill material. The steel sheet pile wall has two locations where fill could be escaping. It should be noted that in review of the construction drawings & in discussions with shipyard personnel, it was determined that the timber deck had not been removed. The timber deck then prevents any loss of fill from on top of the deck through the steel sheet pile, unless the timber decking has failed or has been altered. To determine the cause of the sinkholes along Rowan Avenue, further investigation into the condition of the timber decking, the compactness of the sand fill below the timber decking & the presence of void space between the sand fill and the timber deck will have to be made. Live-load levels on the Rowan Avenue Wharf can be maintained at current levels (600 psf).

The Second Street Wharf has 77 piles which were noted to be defective. Along with the piles are portions of the seawall & longitudinal pile cap which are also damaged. The majority of this damage is a result of berthing & fendering forces which are allowed to effect the bearing piles only through the lack of an adequate fender system. These piles should be repaired. Until repairs are made live-loading directly above broken piles should be restricted to 0 psf.

The Preble Avenue Wharf has 116 piles which exhibit damage serious enough to be repaired. Along with the piles are portions of the seawall & longitudinal pile cap which are also damaged. The majority of this damage is a result of excessive berthing & mooring forces. Generally these berthing/mooring forces are transmitted to the bearing piles through the use of camels. In all locations of damage the fender system has also been rendered non-functional. Until repairs are made live-loading directly above broken piles should be restricted to 0 psf. Due to the sound condition of the timber & upon completion of the recommended repairs, live-load levels on the Preble Avenue Wharf can be maintained at current levels (200 psf).

EXECUTIVE SUMMARY
(Volume III)

→ The inspected facilities covered in Volume III are Wharf F and Pier F, Wharf E, Rowan Avenue Wharf, Second Street Wharf, Preble Avenue Wharf, Broad Street Wharf, Wharf L and Wharf N. ←

Wharf F and Pier F are both in good condition. There are 124 bearing piles which were found to be deficient. Generally the cause of these deficiencies can be attributed to berthing and mooring forces transmitted to the pile through the use of camels. These piles should be repaired. A slight crushing of the pile caps about the perimeter of the wharf and pier was noted. This condition is assumed to be caused by a weakening of the outer timber fibers (softness) and not overloading. At this time the softness is not a threat to the integrity of the structure. Live-loading on Wharf F and Pier F can be maintained at current levels (750 psf).

A partial collapse of the relieving platform of Wharf E has occurred. This collapse is a result of many forces acting in combination against the weakened (due to softness and eccentric loading) structural timber. Apparently, the imposition of a live-load on the top deck of the structure was the "straw that broke the camel's back". Live-loading on the structure from Bents 1 through 58 (newer construction) should remain at 200 psf. On the older structure, Bents 58 through 148, live-loading should be



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A-1	

limited to 100 psf due to the timber softness found. In considering reconstruction of Wharf E, the extension of the Rowan Avenue steel sheet pile bulkhead would be the logical path to follow, particularly to increase the live-load capacity of the structure.

The Rowan Avenue Bulkhead has recently been rehabilitated with the construction of a new steel sheet pile bulkhead and soil anchor system. The steel sheetpiles are in excellent condition with no significant metal loss. There have been problems involving sinkholes behind the steel sheet pile. The sinkholes are caused by the repositioning or settlement of the fill material. The steel sheet pile wall has two locations where fill could be escaping. It should be noted that in review of the construction drawings and in discussions with shipyard personnel, it was determined that the timber deck had not been removed. The timber deck then prevents any loss of fill from on top of the deck through the steel sheet pile, unless the timber decking has failed or has been altered. To determine the cause of the sinkholes along Rowan Avenue, further investigation into the condition of the timber decking, the compactness of the sand fill below the timber decking and the presence of void space between the sand fill and timber deck will have to be made. Live-load levels on the Rowan Avenue Wharf can be maintained at current levels (600 psf).

The Second Street Wharf has 77 piles which were noted to be defective. Along with the piles are portions of the seawall and longitudinal pile cap which are also damaged. The majority of this damage is a result of berthing and fendering forces which are

allowed to effect the bearing piles only through the lack of an adequate fender system. These piles should be repaired. Until repairs are made live-loading directly above broken piles should be restricted to 0 psf. Due to the good condition of the timber and upon completion of the repairs live-load levels on the Second Street Wharf can be maintained at current levels (200 psf).

The Preble Avenue Wharf has 116 piles which exhibit damage serious enough to be repaired. Along with the piles are portions of the seawall and longitudinal pile cap which are also damaged. The majority of this damage is a result of excessive berthing and mooring forces. Generally these berthing/mooring forces are transmitted to the bearing piles through the use of camels. In all locations of damage the fender system has also been rendered non-functional. Until repairs are made live-loading directly above broken piles should be restricted to 0 psf. Due to the sound condition of the timber and upon completion of the recommended repairs, live-load levels on the Preble Avenue Wharf can be maintained at current levels (200 psf).

The Broad Street Wharf has 56 piles which are damaged and in need of repair due to berthing and mooring forces. Soft timber is noted throughout the structure on the Broad Street Wharf. This condition along with the pile spacing of 6 feet on center (typical pile spacing of the relieving platforms throughout the PNSY is 3' to 4' o.c.) greatly reduces the capacity of the timber pile caps. The observed result of these factors is deflection of the pile

caps (approximately 6") at the timber sheet pile wall. This is an indication that the ultimate stresses within the timber are being approached. Further investigation of the material characteristics of the structure should be made. The present live-load capacity of 100 psf on the Broad Street Wharf should be reduced to 50 psf until further investigation can determine the true capacity of the structure.

Wharf L has 117 piles which exhibit damage as a result of excessive berthing and mooring forces. These forces are generated by ships and are transferred to the bearing piles through camels. The fender system adjacent to locations where piles are damaged is generally non-functional. Until repairs are made live-loading directly above the broken piles should be restricted to 0 psf. Upon completion of the recommended repairs, live-loading on Wharf L can be maintained at current levels (200 psf).

Wharf N has 160 piles which are in need of repair. Generally these piles have been damaged by excessive berthing and mooring forces. These forces can only effect the structural piles when there has been a failure of the fender system. These forces are transmitted to the structural piles through camels. Until repairs are made, live-loading should be restricted to 0 psf directly above any broken pile. The steel sheet pile diaphragm portion of the wharf is in excellent condition. There is very little loss of steel due to corrosion. Upon completion of the recommended repairs, live-loading on Wharf N can be maintained at current levels (200 psf).

Refer to the following Executive Summary Table to review each facility's construction, recommendations and cost repair estimates.

PHILADELPHIA NAVAL SHIPYARD
PHILADELPHIA, PENNSYLVANIA

EXECUTIVE SUMMARY TABLE

VOLUME III

<u>FACILITY</u>	<u>YEAR BUILT</u>	<u>TOTAL NO. OF PILES</u>	<u>SIZE (LxW-FT.)</u>	<u>STRUCTURES</u>	<u>RECOMMENDATIONS</u>
Wharf F & Pier F	Circa 1942	7,730	Wharf F 772'x40' Pier F 603'x79'	Timber pile-supported, low deck, earth filled, relieving platform structure	<ol style="list-style-type: none"> 1. Replace or repair broken 2. Repair split and displaced bearing and wild piles 3. Repair damaged pile caps 4. Re-inspect after repairs
Wharf E	Bents 1-58 Circa 1942 Bents 59-148 Circa 1914- 1915	N/A	730' in length	Timber pile-supported, low deck, earth filled, relieving platform structure	<ol style="list-style-type: none"> 1. Replace or repair broken 2. Repair split and displaced 3. Repair damaged pile cap 4. Limit live-load capacity Bent 58-148 5. Enforce dredge limits 6. Consider steel sheet pile for collapsed portion of 7. Re-inspect yearly
Rowan Ave. Bulkhead	Circa 1982	N/A	1,971' in length	Steel sheet pile wall and tie-back structure	<ol style="list-style-type: none"> 1. Patch honeycombed portions 2. Cut steel formwork flush 3. Repair separations in sheet 4. Conduct 12 test borings 5. Investigate flume association 6. Re-inspect after repairs
Second St. Wharf	Circa 1902- 1903	528	928' in length	Timber pile-supported, low deck, earth filled, relieving platform structure	<ol style="list-style-type: none"> 1. Replace or repair broken 2. Repair longitudinal pile 3. Repair split and displaced and partially bearing pile 4. Consider installing fender 5. Restrict live-loading in until repairs are completed 6. Re-inspect in 2 years

*Cost estimates based on 1983 U.S. East Coast prices.
Mobilization/demobilization costs have been omitted.

PHILADELPHIA NAVAL SHIPYARD
PHILADELPHIA, PENNSYLVANIA

EXECUTIVE SUMMARY TABLE

VOLUME III

RECOMMENDATIONS

ported, low
 led, relieving
 ure

1. Replace or repair broken piles
2. Repair split and displaced, non-bearing, wind partially bearing and wind piles
3. Repair damaged pile caps
4. Re-inspect after repairs and in 3 years thereafter.

Estimated
 Cost

ported, low
 led, relieving
 ure

1. Replace or repair broken piles
2. Repair split and displaced piles
3. Repair damaged pile cap
4. Limit live-load applied to 100 psf between Bent 58-143
5. Enforce dredge limits
6. Consider steel sheet pile and fender system for collapsed portion of wharf
7. Re-inspect yearly

le wall and
 ure

1. Patch nonexposed portion of seawall
2. Cut steel formwork flush to concrete face
3. Repair separations in sheet pile wall
4. Conduct 12 test borings
5. Investigate flume associated with 21 Pier D
6. Re-inspect after repairs and in 3 years thereafter.

ported, low
 led, relieving
 ure

1. Replace or repair broken piles
2. Repair longitudinal pile cap
3. Repair split and displaced, non-bearing, wind and partially bearing piles
4. Consider installing fender system
5. Restrict live-loading in areas of missing piles until repairs are completed
6. Re-inspect in 2 years

PHILADELPHIA NAVAL SHIPYARD EXECUTIVE SUMMARY TABLE - Cont

VOLUME 111

<u>FACILITY</u>	<u>YEAR BUILT</u>	<u>TOTAL NO. OF PILES</u>	<u>SIZE (LxW-FT.)</u>	<u>STRUCTURES</u>	<u>RECOMMENDATIONS</u>
Preble Ave. Wharf	Circa 1900	370	847' in length	Timber pile-supported, low deck, earth filled, relieving platform structure	<ol style="list-style-type: none"> 1. Replace or repair broken p 2. Repair longitudinal pile c 3. Repair split and displaced wild piles 4. Consider installing fender 5. Restrict live-loading in a until repairs are complete 6. Re-inspect after repairs a
Broad St. Wharf	Circa 1899	1,440	735' in length	Timber pile-supported, low deck, earth filled, relieving platform structure	<ol style="list-style-type: none"> 1. Limit live-load capacity to and west lane of Broad Str 2. Consider long-term recondi 3. Replace or repair broken p 4. Repair split and displaced partially bearing piles 5. Monitor on 6-month interva
Wharf L	Circa 1900	400	930' in length	Timber pile-supported, low deck, earth filled, relieving platform structure	<ol style="list-style-type: none"> 1. Replace or repair broken p 2. Repair longitudinal pile c 3. Repair split and displaced partially bearing piles 4. Consider installing fender 5. Restrict live-loading in a until repairs are completed 6. Re-inspect after repairs a
Wharf N	Station 0+00 to 9+75, Circa 1903 Station 14+00 to 19+50, Circa 1941 Remaining Timber Circa 1943 Steel Sheet Piles Unknown	3,646	3,348' in length	Sta. 0+00 to 21+88, Timber pile-supported, low deck, earth filled, relieving platform structure Sta. 21+88 to 33+48, Steel sheet pile diaphragms	<ol style="list-style-type: none"> 1. Replace or repair broken p 2. Repair split and displaced bearing and wild piles 3. Repair damaged pile cap 4. Monitor bulge at Sta. 21+88 5. Consider installing fender 6. Restrict live-loading in a until repairs are completed 7. Re-inspect timber portion Re-inspect remainder of wha

*Cost estimates based on 1983 U.S. East Coast prices.
Mobilization/demobilization costs have been omitted.

PHIA NAVAL SHIPYARD EXECUTIVE SUMMARY TABLE - Cont'd.

VOLUME III

	RECOMMENDATIONS	ESTIMATED COST* (THOUSANDS)
Supported, low filled, relieving structure	<ol style="list-style-type: none"> 1. Replace or repair broken piles 2. Repair longitudinal pile cap 3. Repair split and displaced, non-bearing and wild piles 4. Consider installing fender system 5. Restrict live-loading in areas of missing piles until repairs are completed 6. Re-inspect after repairs and in 2 years thereafter. 	<p>87</p> <p>12.6</p> <p>11.6</p> <p>--</p> <p>--</p> <p>--</p>
Supported, low filled, relieving structure	<ol style="list-style-type: none"> 1. Limit live-load capacity to 50 psf on sidewalk and west lane of Broad Street 2. Consider long-term reconditioning or reconstruction. 3. Replace or repair broken piles 4. Repair split and displaced, wild, non-bearing and partially bearing piles 5. Monitor on 6-month intervals 	<p>--</p> <p>--</p> <p>13</p> <p>17.2</p> <p>--</p>
Supported, low filled, relieving structure	<ol style="list-style-type: none"> 1. Replace or repair broken piles 2. Repair longitudinal pile cap 3. Repair split and displaced, non-bearing, wild, and partially bearing piles 4. Consider installing fender system 5. Restrict live-loading in areas of missing piles until repairs are completed. 6. Re-inspect after repairs and in 2 years thereafter. 	<p>99</p> <p>15.9</p> <p>7.2</p> <p>--</p> <p>--</p> <p>--</p>
21+88, Timber ed, low deck, relieving structure	<ol style="list-style-type: none"> 1. Replace or repair broken piles 2. Repair split and displaced, non-bearing, partially bearing and wild piles 3. Repair damaged pile cap 4. Monitor bulge at Sta. 21+88 5. Consider installing fender system 6. Restrict live-loading in areas of missing piles until repairs are completed 7. Re-inspect timber portion of wharf in 2 years. Re-inspect remainder of wharf on a 6-year basis 	<p>92</p> <p>27.2</p> <p>0.5</p> <p>--</p> <p>--</p> <p>--</p> <p>--</p>
33+48, Steel aphragms		

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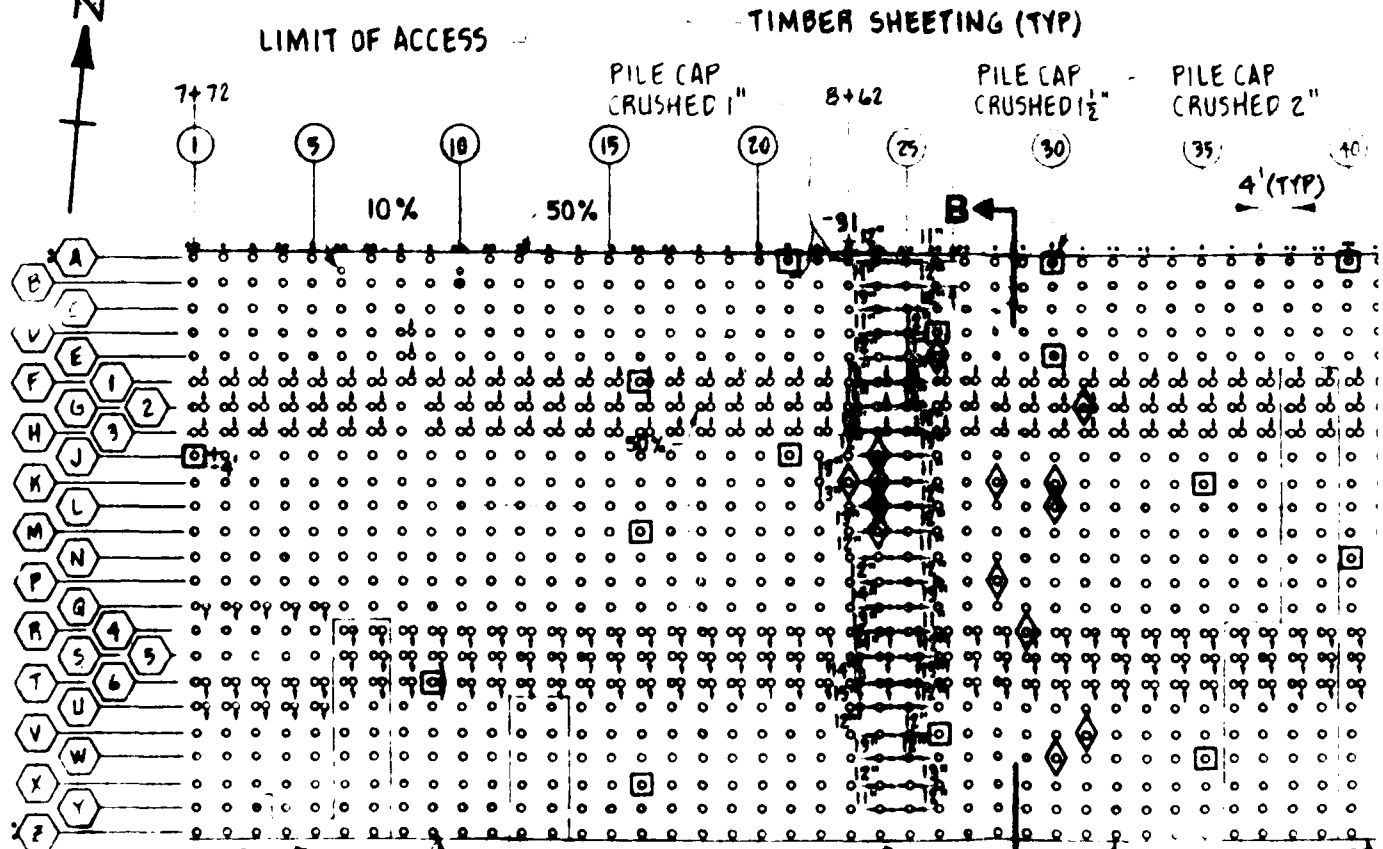
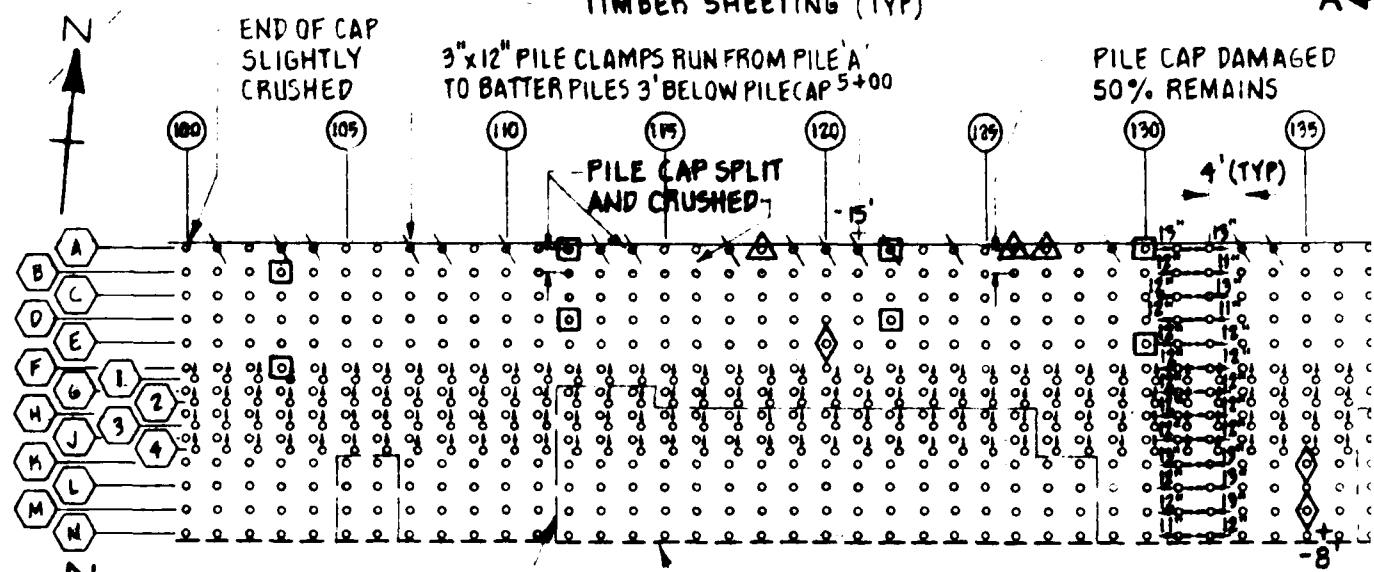
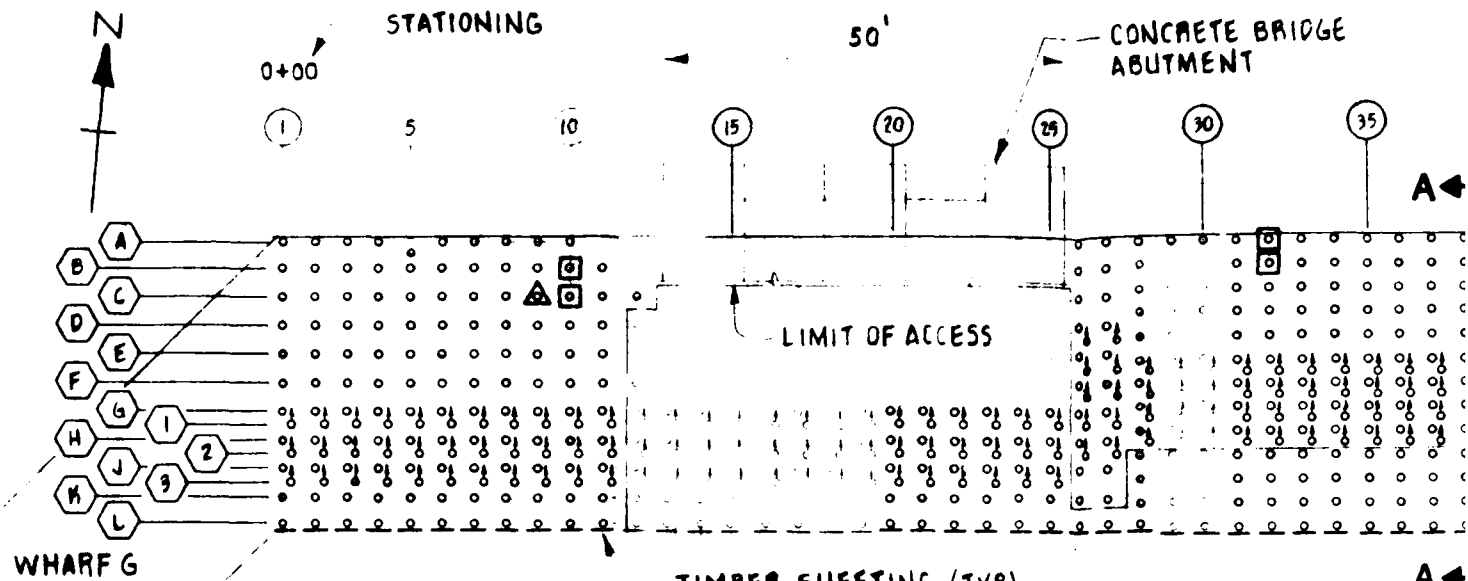
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4.13 WHARF F & PIER F

4.13.1 DESCRIPTION

Wharf F and Pier F provide the southern boundary of the entrance channel to the Reserve Basin, (see Figures 4, [Vol. I] and 79). To the west Wharf F begins at Wharf G. To the east Wharf F transforms into Pier F which parallels the marine railway tracks. Both facilities were constructed circa 1942. Both structures consist of timber pile-supported, low deck, earth filled, relieving platform structures. The combined total number of piles is approximately 7,730. The overall length of both structures is approximately 1,375'. The assumed pile capacity is 15 tons. The loading limit presently designated on both structures is 750 psf. Both facilities were idle during our inspection.

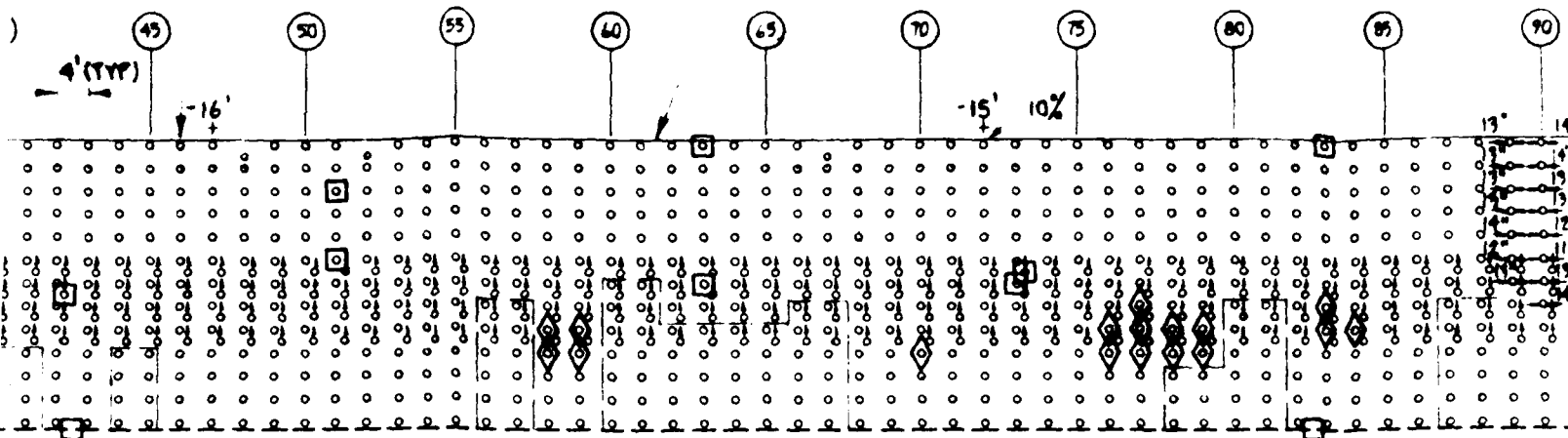
Reference 2 (see Appendix A-29)



PILE SLIGHTLY DAMAGED
AT MUCL NE-2" DEEP GASH

FACE OF WHARF
(TYP) 3+00

1+98



PLAN - WHARF F

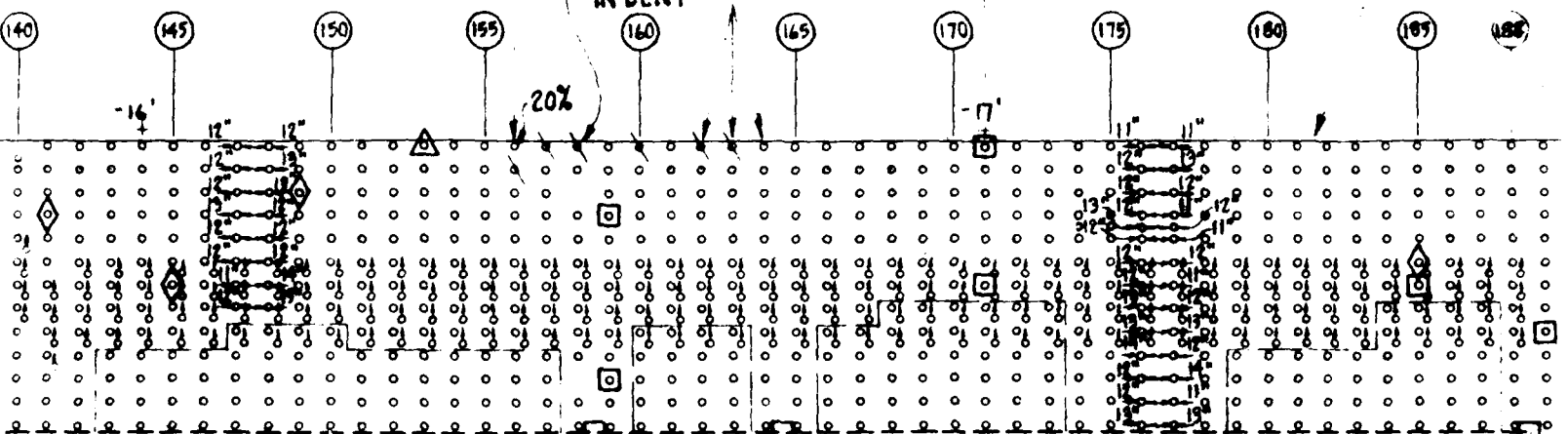
6+00 SCALE AS SHOWN

PILE & PILE CAP
ABRATED

11 PILES
IN BENT

A PILES TOP PORTION
ABRATED TIMBER
SOFT 1 1/2" DEEP

FACE OF WHARF
(TYP) 7+12



PLAN - WHARF F

SCALE AS SHOWN

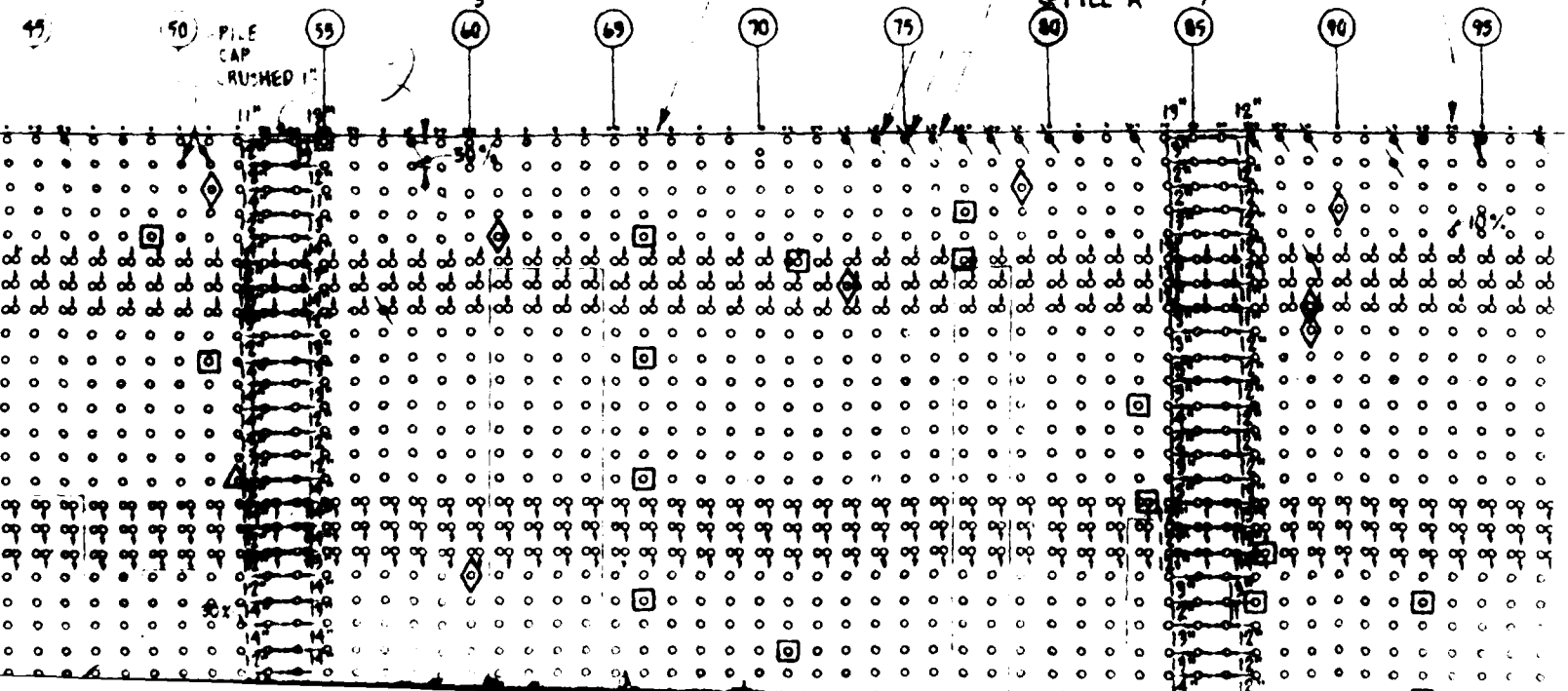
PILE CAP
SPLIT,
MISSING

FACE OF PIER
(TYP)

PILE CAPS SPLIT
& BROKEN
PILE A

BENT NO.
(TYP)

PILE CAP
CRUSHED



LEGEND

△ WILD PILE

◇ NON-BEARING PILE

• BROKEN PILE

↘ DISPLACED-SPLIT PILE

□ CORE LOCATION (PILE, CAP, DECK) LEVEL 3 INSPECTION

10" → MINIMUM PILE DIAMETER, LEVEL 2 INSPECTION

-25' SOUNDINGS IN FEET BELOW MLW

50% 80% OF PILE BEARING ON PILE CAP

○ TIMBER BEARING PILE

! TIMBER BATTER PILE

③ BENT NO. DESIGNATION

Ⓔ PILE DESIGNATION

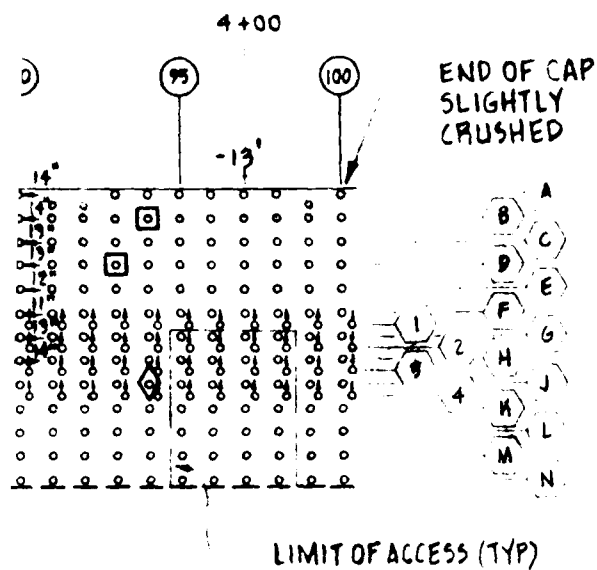
• MODIFIED LEVEL 1 INSPECTION } PERFORMED ON ALL PILES
• LEVEL 1 INSPECTION } WITHIN BENT OR ROW

NOTES :

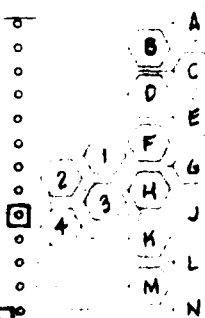
1. LEVEL 1 INSPECTION PERFORMED ON ALL PILES OF WHARF F - HIGHER LEVELS OF INSPECTION WHERE NOTED.

2. CORE SAMPLES INDICATE 1" OF SOFTNESS, A TYPICAL CONDITION.

3. REFERENCE : HUDSON ENGINEERS REPORT-1976
SHT 1, PWC-9219, PWB-9275, PWC-10833,
PWMP-54, PWMA-112, PW-1089432,
PW-1089432, PWC-10836.

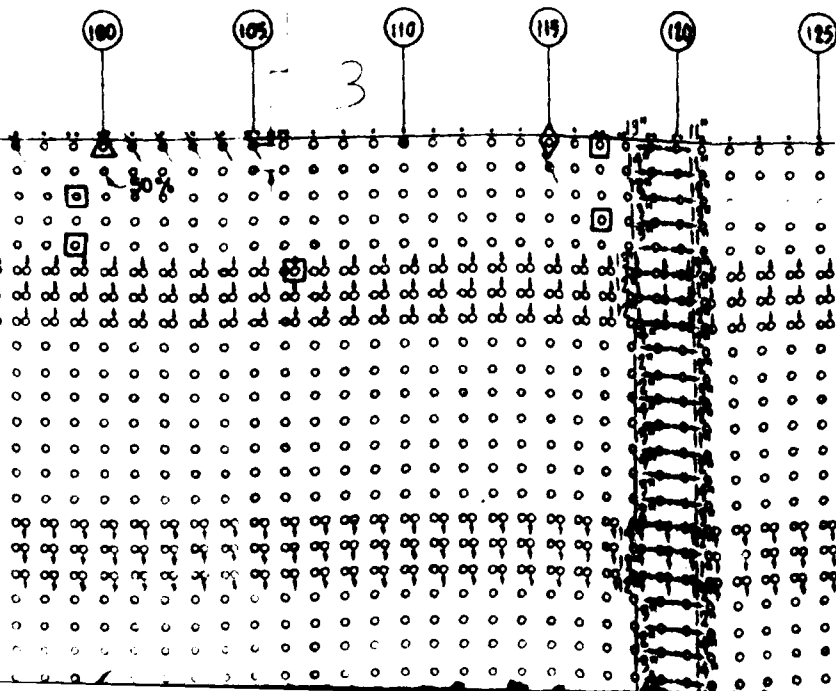


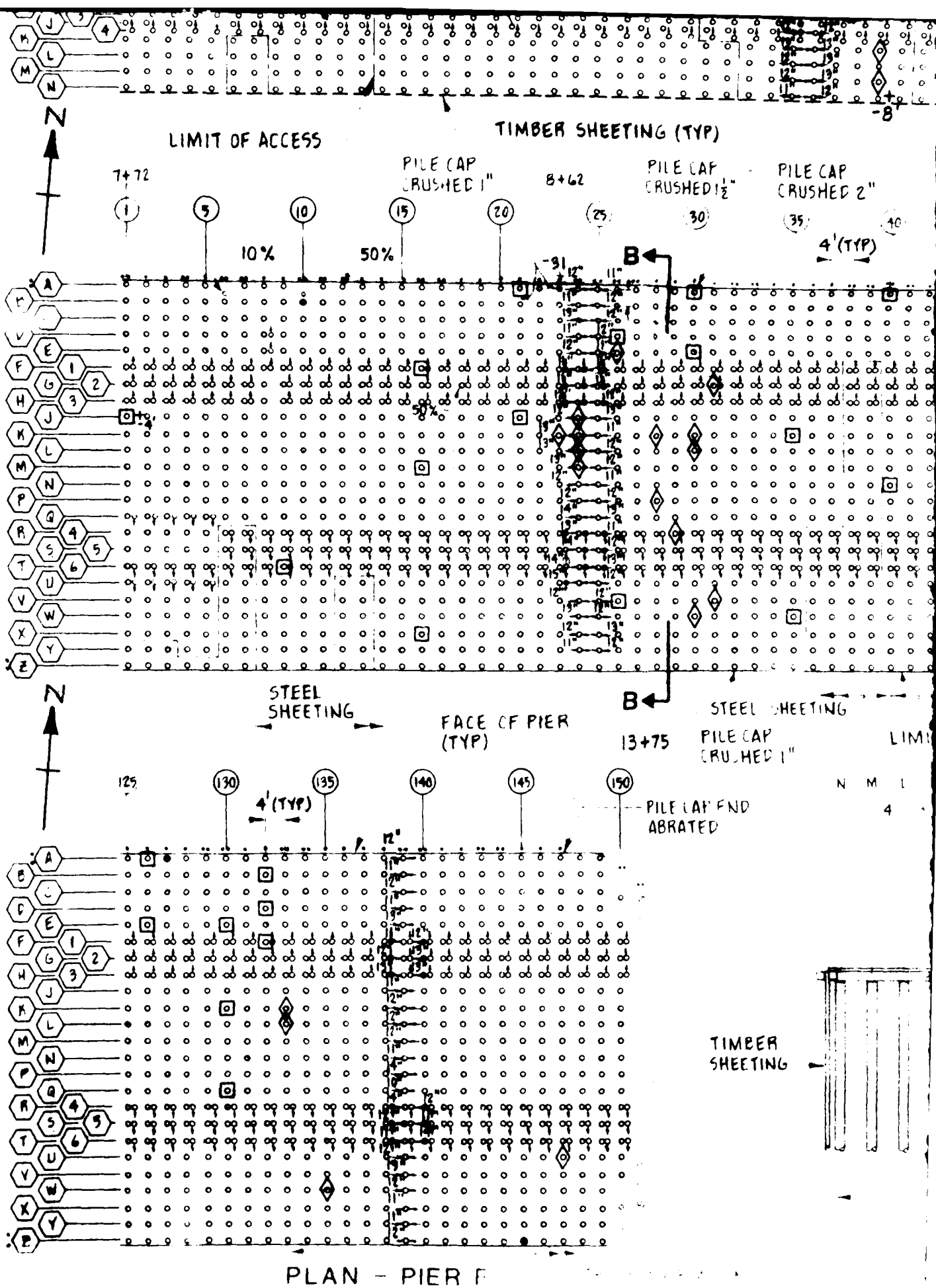
+72
1 - BENT NO. 1 - PIER F



E CAP
CRUSHED 1"

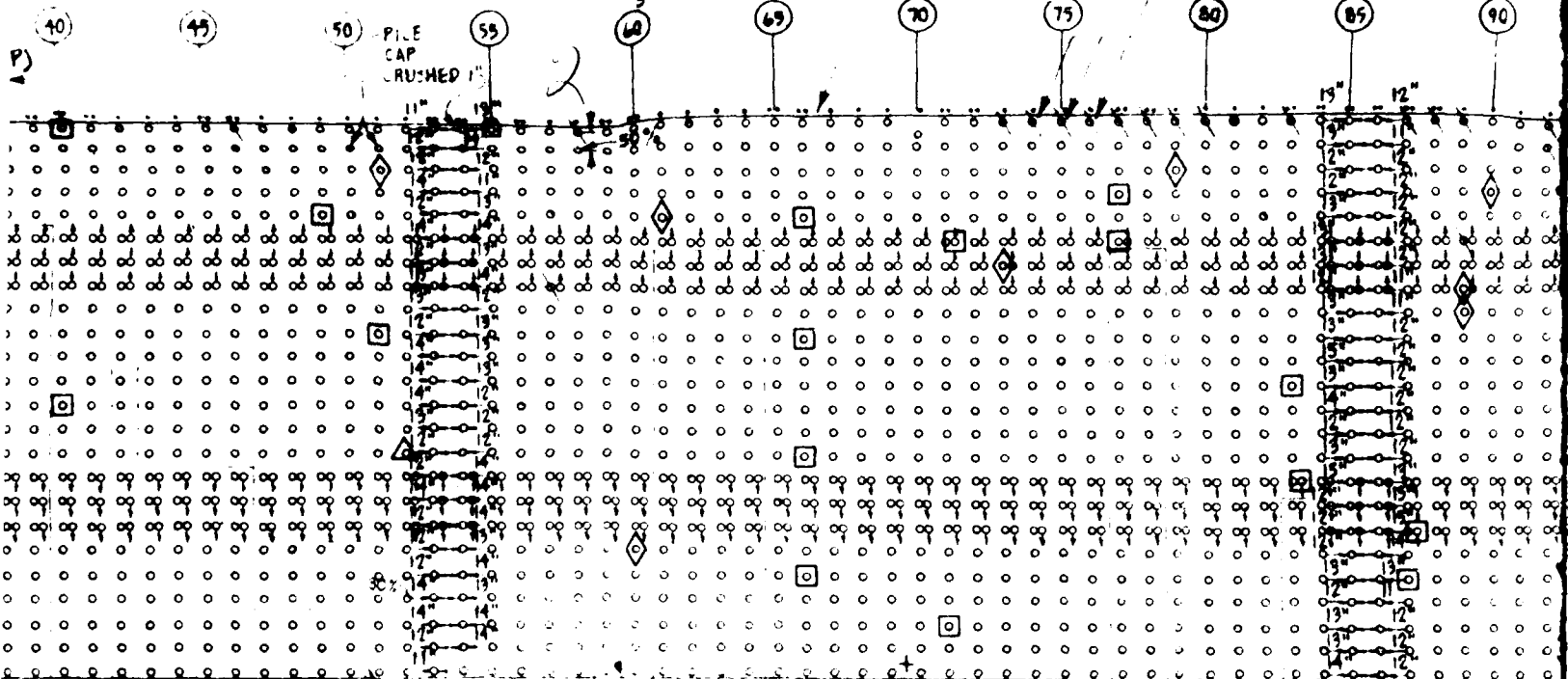
PILE CAP IS SPLIT
& SAGGING





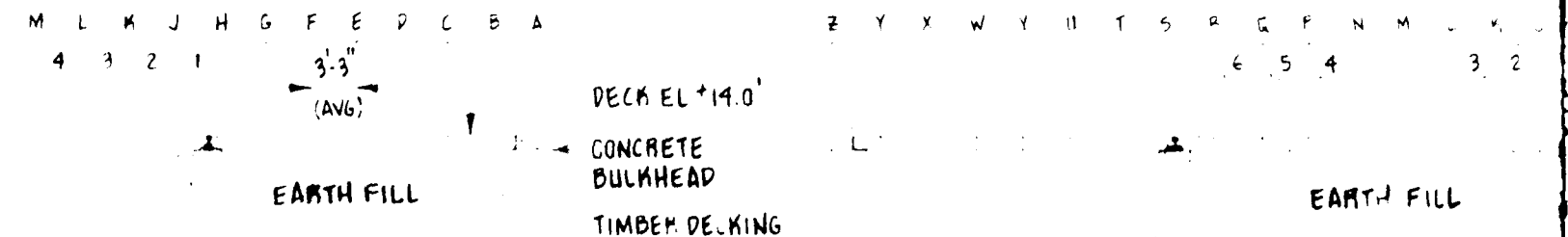
PLAN - WHARF F

SCALE AS SHOWN



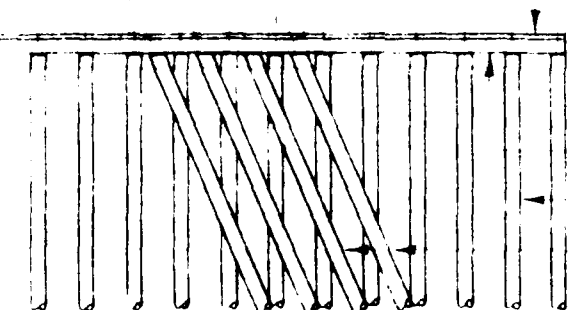
PLAN - PIER F

SCALE AS SHOWN



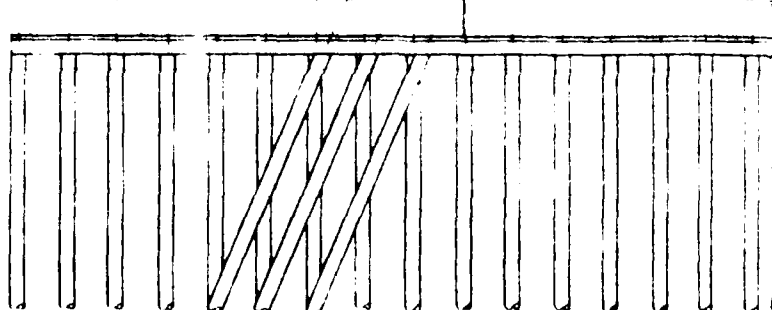
SECTION A-A

SCALE: 1"=10'



SECTION B-B

SCALE: 1"=10'

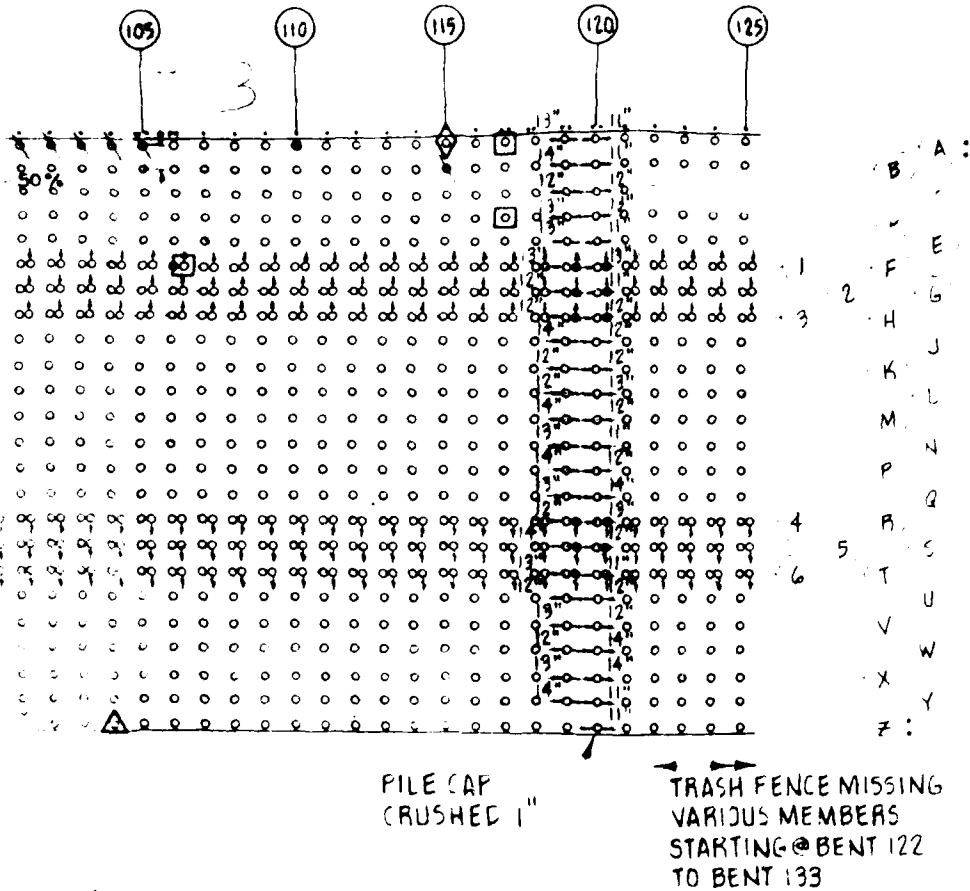


WHARF F - HIGHER LEVELS OF INSPECTION WHERE NOTED.

2. CORE SAMPLES INDICATE 1" OF SOFTNESS,
A TYPICAL CONDITION.

3. REFERENCE: HUDSON ENGINEERS REPORT-1976
SHT 1, PWC-9219, PWB-9275, PWC-10855,
PNMP-54, PWR-112, PW-1089432,
PW-1089432, PWC-10856.

PILE CAP IS SPLIT
& SAGGING



DECK EL +14.0'

CONCRETE
BULKHEAD

TIMBER DECKING

MLW EL +0.6'

PILE CAP

BEARING PILES

BATTER PILES

GRAPHIC SCALE

CHILDS ENGINEERING
CORPORATION

BULK 134
WEDNESDAY

CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND

WASHINGTON, D.C.

PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA

FIG NO

WHARF F & PIER F

79

4.13.2 OBSERVED INSPECTION CONDITION

Quantities of specific anomalies related to the structural piles are listed as follows:

Wharf F:	0 - Broken piles
	23 - Split and displaced piles
	25 - Non-bearing piles
	5 - Wild piles
	2 - Partially-bearing piles
Pier F:	7 - Broken piles
	25 - Split and displaced piles
	27 - Non-bearing piles
	3 - Wild piles
	7 - Partially-bearing piles

These anomalies can be located on Figure 79.

The core samples taken at selected locations indicate that the timber generally has approximately 1/2" to 1" of softness (see Photo #46). Minimum pile diameters which were observed ranged from 11" to 15". The fasteners have a light corrosion by-product on the exposed metal surface and have very little loss of metal. Approximately 20% of the pile caps on the north perimeter of the wharf and the total perimeter of the pier exhibit some minor crushing (see Photo #47 for typical pile-pile cap junctions). The caps which have significant crushing (1" or more) are located on Figure 79. The typical crushing profile is detailed on Figure 7. (See Photos #48, 49, 50, 51 for illustrations of pile cap damage.) Crushing of the pile caps is apparently due to overloading the pile cap from the surface of the structure along with a weakening of the timber. Other damage to the pile cap such as splitting or abrasion is caused by the use of fendering camels. On Pier F the



PHOTO NO. 46: Pier F, Bent 98, Pile C;
illustrates typical core location
on a cleaned pile. Note drill
and bitt with core in place to
right side of photo.

PHOTO NO. 47: Wharf F, Bent 123, Pile A;
illustrates typical condition of
timber pile and pile cap. Pile
is approx. 14" in diameter.



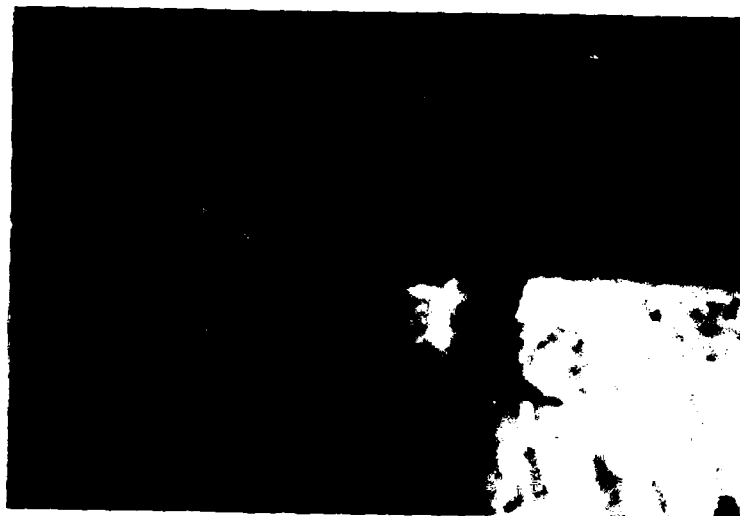


PHOTO NO. 48: Pier F, Bent 120, Pile Z; close-up photo looking at the pile cap end where it is bearing on the pile, illustrating 1" of crushing of the pile cap.

PHOTO NO. 49: Pier F, Bent 120, Pile Z; close-up shot of the timber pile cap and timber pile junction which illustrates the compression of the timber fibers of pile cap in the area of bearing on pile.



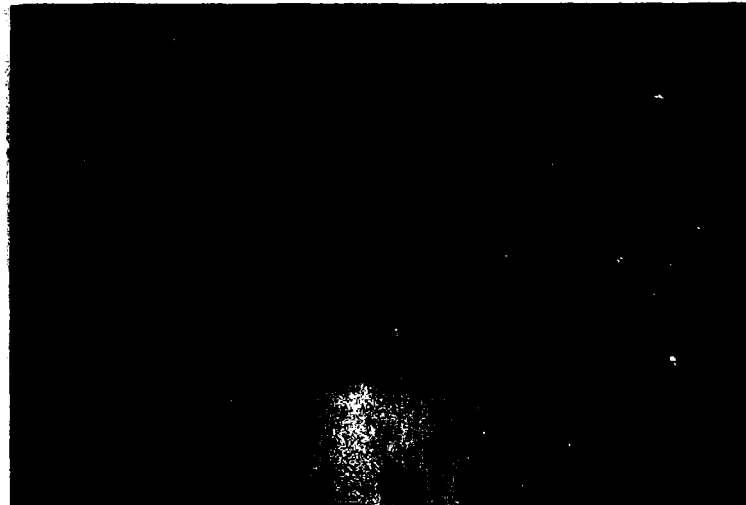
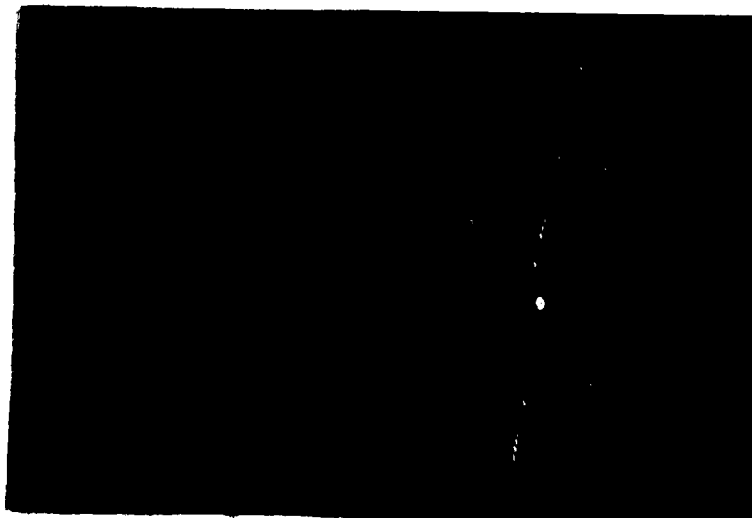


PHOTO NO. 50: Wharf F, Bent 116, Pile B;
illustrates cracking and failure
of timber pile cap over pile.
Pile diameter is approx. 14".

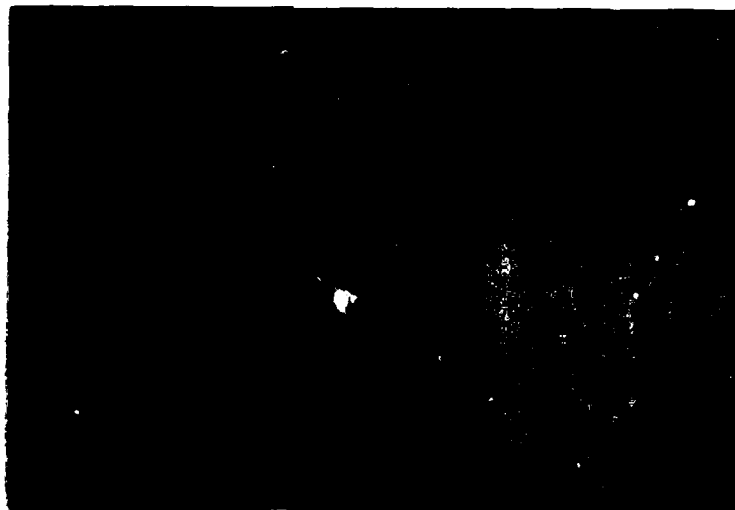
PHOTO NO. 51: Pier F, Bent 116, Pile A;
timber pile cap as viewed from
below relieving platform showing
drift pin hole and 1" wide crack.



concrete curb at the perimeter of the pier is beginning to deteriorate. The most significantly deteriorated portion of the curbing is at the cleat locations and around the scuppers. Hairline cracking of the concrete can be found on the curbing throughout the pier. Generally the curbing along the wharf is significantly less deteriorated. The seawall along the wharf and the pier exhibits little or no deterioration of the concrete and there is little vertical or horizontal distortion. Timber and steel sheet pile appear to be in good condition where access was available, (see Photo #52).

The fender piles along the wharf and pier are in sound condition. The wales are exhibiting fungal attack (dry rot) but they are functional. There are nine locations where the pile cap has incurred damage along the perimeter of the wharf and pier. In all cases the pile cap has been split and in some cases it has failed.

PHOTO NO. 52: Wharf F, Bent 110; illustrates
typical tight joint between
timber sheet piles.



4.13.3 STRUCTURAL ASSESSMENT

Damage which occurs at the perimeter of the wharf and pier is attributed to excessive horizontal loading (berthing and mooring forces) transmitted to the structural piles by the fendering camels.

Minimum pile diameters indicate that there has been no loss of cross-sectional area of the timber piles since they were driven. The timber softness detected throughout both facilities is not structurally significant at this time. Calculations of the strength of the structures (see Appendix A-1 to A-15) indicate it is fully capable of supporting its designated live-load capacity (750 psf).

The slight crushing of the pile caps is obviously a condition of overstressing the pile cap timber resulting in local failure. The timber is overstressed due to a loss of strength of the outer layer of fibers (softness). This outer layer of softness ranges from 0" to 2". The inner timber fibers are not effected by the softness, this is evident by the observation of local failure of the outer timber fibers. At this time the local crushing failure is not significant to the overall structural integrity due to the remaining strength of the unaffected timber. However, at some point in time the softness of the timber will become structurally significant due to the fact that the pile cap's strength perpendicular to the wood grain is the limiting factor of the strength of the pile cap (see Appendix A-14).

The deterioration of the concrete curbing about the perimeter of the wharf and pier is not structurally significant. Deterioration of the fender system is not significant (except mechanically damaged areas) and the fender system is functional.

4.13.4 RECOMMENDATIONS

All mechanically damaged piles should be repaired. The 7 broken piles should be recommissioned. At the perimeter of the pier a new pile should be driven and pulled in below the existing pile cap and shimmed (see Appendix A-20). At the interior of the pier broken piles should be long-posted (see Appendix A-23). The estimated cost per pile is \$1,000, the total estimated cost is \$7,000. The 57 split, displaced and partially-bearing piles should be repaired at an estimated cost of \$400/pile, the total estimated cost is \$22,800. The 52 non-bearing piles should be shimmed as needed, the 8 wild piles should be refastened to the pile cap. The estimated cost per pile is \$400, the total estimated cost is \$24,000. The nine pile caps which are damaged should be repaired with a sistered pile cap (see Appendix A-24). The estimated cost per repair is \$500. The total estimated cost is \$4,500. Repair details are located in Appendix A-20 to A-27.

Live-loading in deck areas directly associated with damaged (broken, split and wild) piles should be restricted to 25% of the current recommended live-load capacity until those piles are repaired. Following implementation of the recommended repairs, live-loading can be maintained at current levels (750 psf). The estimated remaining life of Wharf F and Pier F is in excess of 20 years.

The entire wharf and pier should be re-inspected in 6 years. This will enable base personnel to determine any change in conditions. This report should be used as a baseline for future inspections.

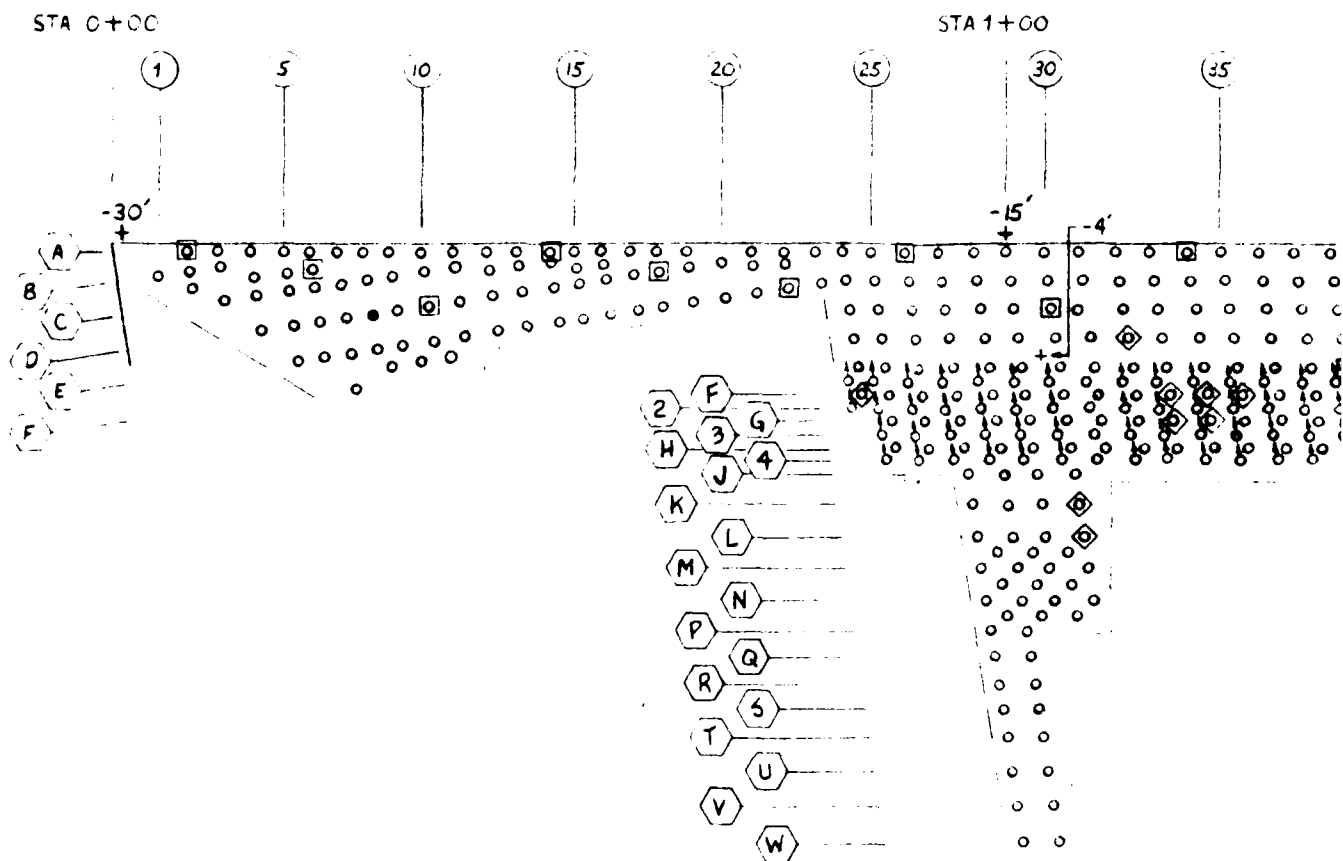
4.14 WHARF E

4.14.1 DESCRIPTION

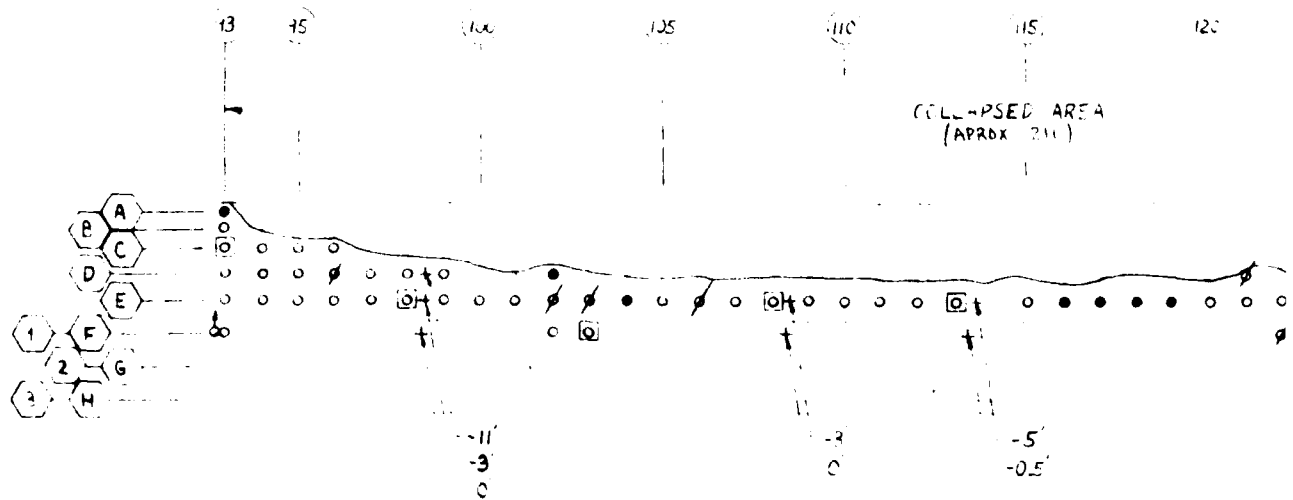
Wharf E forms the western perimeter of the Reserve Basin. It is bordered to the south by Rowan Avenue and to the north by Marine Railways 1 and 2, (see Figures 4 [Vol. I] and 80). It is a timber pile-supported, low deck, earth-filled, relieving platform structure which is approximately 730' long. Bents 1 through 58 were constructed Circa 1942, the remainder of the wharf was constructed Circa 1914-1915. The driven pile capacity is assumed to be 15 tons. The bents are arranged on 5' centers while the pile spacing ranges from 3' to 5'. The top deck elevation is +14'. During our inspection the wharf was idle and portions of the wharf were barricaded due to a partial collapse of the structure.

Reference 2 (see Appendix A-29)

MARINE RAILWAY



RESERVE BASIN



PLAN

Z ←

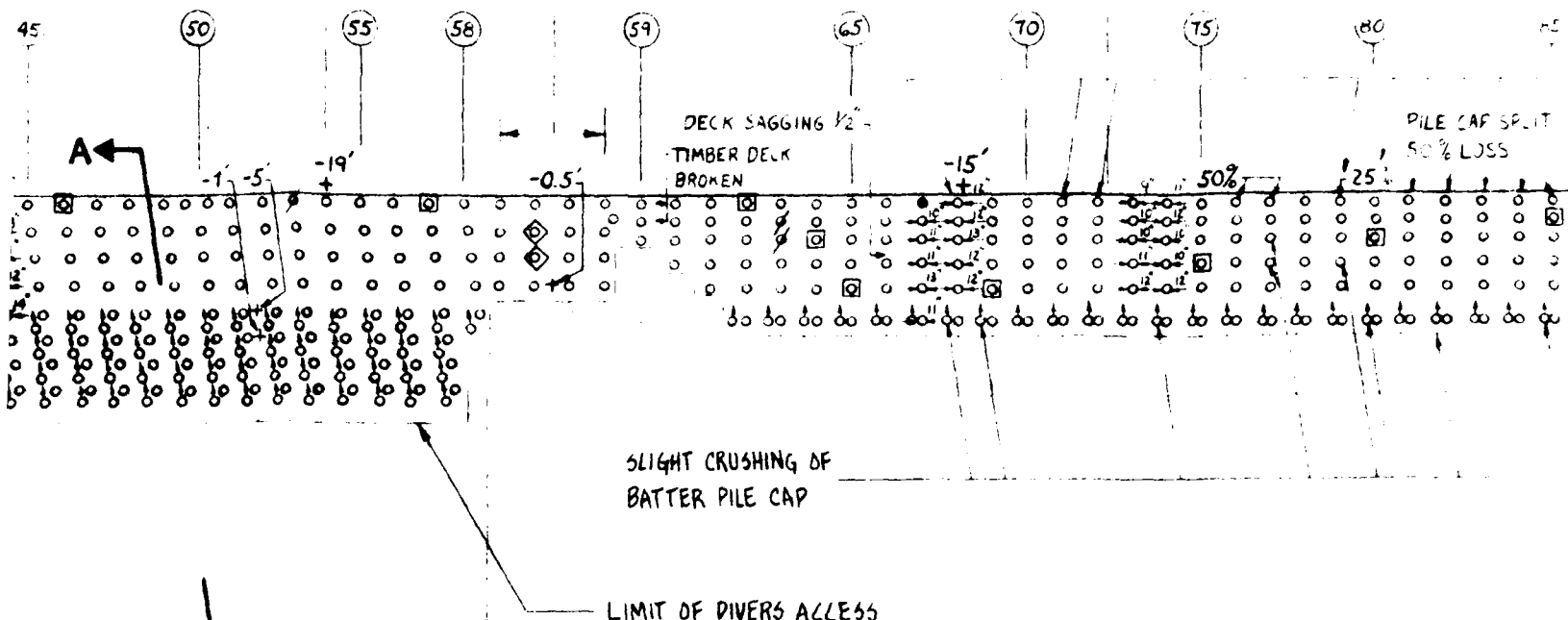
IE BASIN

CONSTRUCTED CIRCA 1942
STA 2+00

PILE CAPS IN TRANSITION
ZONE RUN NORTH AND SOUTH

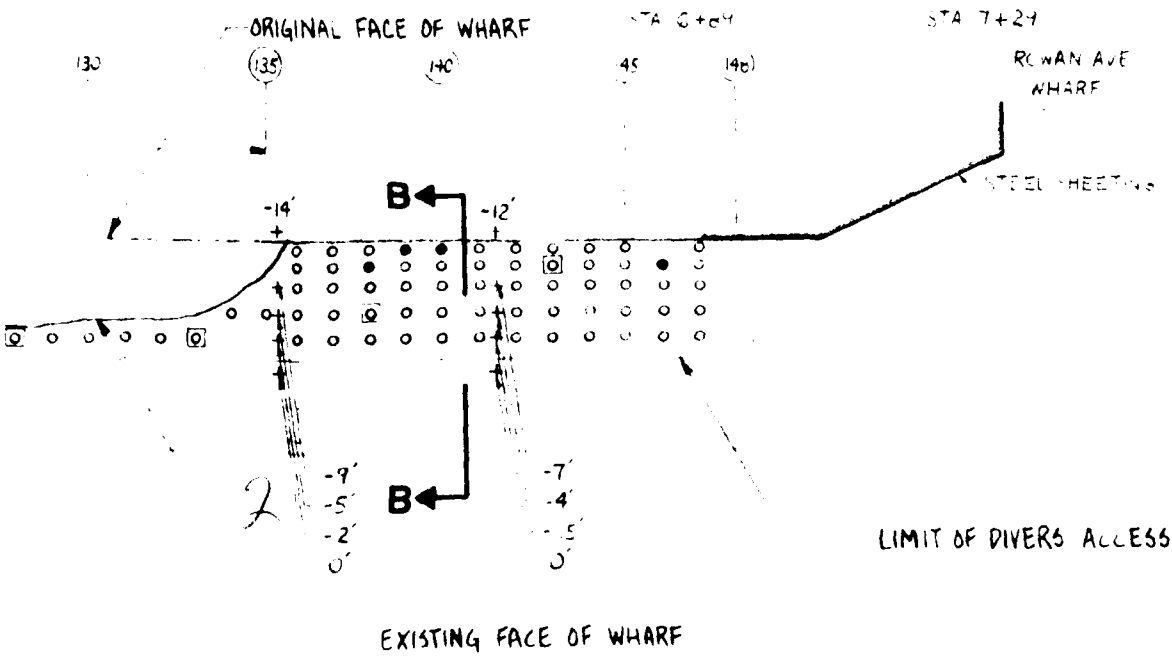
— CONSTRUCTED CIRCA 1915

STA 3+00

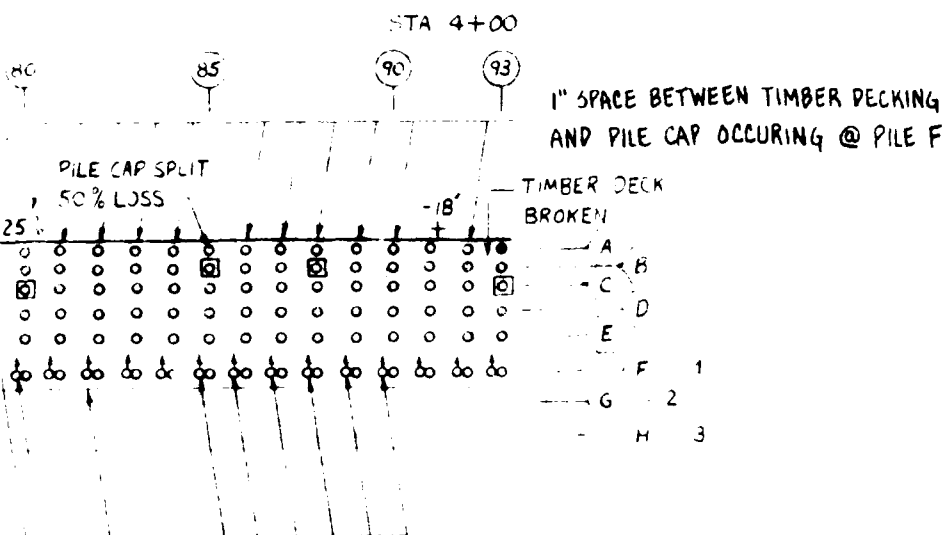


PLAN

10 0 10 20 30 40 50
SCALE OF FEET



Z ←



LEGEND

- △ WILD PILE
- ◇ NON-BEARING PILE
- BROKEN PILE
- ↘ DISPLACED-SPLIT PILE
- CORE LOCATION (PILE, CAP, DECK) LEVEL 3 INSPECTION
- 10" — ○ MINIMUM PILE DIAMETER, LEVEL 2 INSPECTION
- 25' SOUNDINGS IN FEET BELOW MLW
- 50% 8 50% OF PILE BEARING ON PILE CAP
- TIMBER BEARING PILE
- ⊙ TIMBER BATTER PILE
- ③ BENT NO. DESIGNATION
- Ⓔ PILE DESIGNATION

NOTES:

1. LEVEL 1 INSPECTION ON ALL PILES-HIGHER LEVELS OF INSPECTION WHERE NOTED.
2. CORE SAMPLES INDICATE 1" OF SOFTNESS, A TYPICAL CONDITION.

2. FROM BENT 101

13 15 18 25 30 35 42

The diagram is a geological cross-section of a hill. The profile is defined by a series of points connected by a line. On the left side, there are labels A, B, C, D, E, F, G, and H, each enclosed in a small circle. Below these, there are labels 1, 2, 3, and 4, also in circles. The profile itself has several points marked with circles, some of which are labeled with letters or numbers. Below the profile, there are several labels indicating elevations or depths: -11', -3', -5', and -25'. The diagram is a black and white line drawing.

10 0 10 20

T S R Q P N M L K J H G F E D C B A
4 3 2 1

FILL

TIME- 1 FC.

MA 3

$P_{12} \in \mathcal{A}$

FILE - 1 - 1

BATTER PILES

TIMBER
SHEETING

5 0 5 10 20

SCALE OF FEET

10 0 10 20 30 40 50
SCALE OF FEET



ALE OF FEET

H G F E D C B A
 3 2 1

FEAR.

BATTER PILES --

5 0 5 10 20
SCALE OF FEET

- △ WILD PILE
- ◇ NON-BEARING PILE
- BROKEN PILE
- ↘ DISPLACED-SPLIT PILE
- CORE LOCATION (PILE, CAP, DECK) LEVEL 3 INSPECTION
- 10" — ○ — MINIMUM PILE DIAMETER, LEVEL 2 INSPECTION
- 25' SOUNDINGS IN FEET BELOW MLW
- 50% 50% OF PILE BEARING ON PILE CAP
- TIMBER BEARING PILE
- ⊥ TIMBER BATTER PILE
- ③ BENT NO. DESIGNATION
- ⬡ PILE DESIGNATION

NOTES:

1. LEVEL 1 INSPECTION ON ALL PILES-HIGHER LEVELS OF INSPECTION WHERE NOTED.
2. CORE SAMPLES INDICATE 1" OF SOFTNESS, A TYPICAL CONDITION.
3. FROM BENT 68 TO BENT 195 CRUSHING OF THE PILE CAP OCCURS @ APPROX 50% OF PILE/CAP JUNCTIONS.
4. IN LOCATIONS WHERE THE BATTER PILE CAP IS CRUSHED, THE TIMBER DECKING IS LIFTED OFF THE BEARING PILE CAP

REFERENCE

P.W. B-3275
 P.W. C-3336
 P.W. C-9219
 P.W. C-10833
 P.W. C-10863
 P.W. C-13539
 P.W. C-25461
 P.W. E-1697
 NAVFAC 124039B
 HUDSON ENGINEERS SURVEY-1976 SHT 14.

GRAPHIC SCALE

AS SHOWN

CHILDS ENGINEERING
 CORPORATION
 BOX 333
 MEDFIELD, MA

CHESAPEAKE DIVISION
 NAVAL FACILITIES ENGINEERING COMMAND
 WASHINGTON, D.C.

PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA

WHARF E

FIG. NO.

80

4.14.2 OBSERVED INSPECTION CONDITION

From Bent 93 through 135 the structure has partially collapsed. The A, B, C, D piles in this area are broken with some of the E piles also broken. The seawall, earth fill, low deck and pile caps back to the batter pile bents have rotated and collapsed out-shore, (see Photos #53, 54, 55). Debris consisting of the broken piles, pile caps, timber deck, concrete seawall and various utility pipes is laying on the river bottom as far as 70' from the original wharf face. At the batter pile bents the vertical bearing pile cap is only partially bearing with as much as a 1" gap between the pile cap and deck timber. Associated with that condition is a crushing of the batter pile cap.

In that portion of the wharf which is unaffected by the partial failure, quantities of specific anomalies are listed as follows:

- 6 - Broken piles
- 3 - Split and displaced piles
- 11 - Non-bearing piles
- 4 - Partially-bearing piles

The locations of these anomalies can be found on Figure 80.

Observations of timber core samples taken from the piles, pile caps and decking indicate that typically the piles have 1-1/2" of soft timber. Timber decking and pile caps generally have 1/2" to 1" of soft timber. Minimum pile diameters measured averaged 12" with the smallest being 9". There has been no change in the cross-sectional area of the timber piles since they were driven.

The concrete seawall had little cracking and showed no sign of settlement or displacement. The fender system along the wharf is



PHOTO NO. 53: Wharf E, Bent 121, Pile D;
illustrates broken timber pile
cap and split timber pile.
Pile diameter is approx. 14".

PHOTO NO. 54: Wharf E, Bent 121, Pile D;
broken timber pile cap. Note
exposed drift pin.



PHOTO NO. 55: Wharf E, Bent 92, between Piles A and B; photo of timber deck planks taken from below the relieving platform shows 1/4" to 1/2" gap between deck planks indicating movement.



in good condition although there are damaged sections. From Bents 59 through 148 the mudline assumes a near vertical slope between the E and F piles. Bent 85, at the perimeter of the wharf, the pile cap is damaged (see Photo #56). In its present condition, the pile cap is not functional.

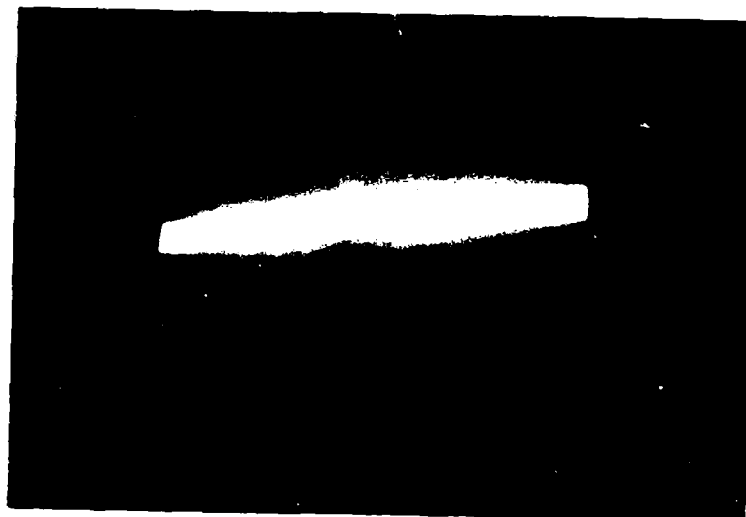


PHOTO NO. 56: Wharf E, Bent 85, Pile A;
illustrates damaged timber pile cap.
Note shim between pile and pile cap.

4.14.3 STRUCTURAL ASSESSMENT

The partial failure of a section of Wharf E can be traced to a combination of weaknesses. The primary cause of the failure of the relieving platform was excessive eccentric loading and combined stresses leading to the eventual overstressing of the pile caps and timber piles. In discussions with Shipyard personnel it was determined that during the time of the failure there was a considerable live-load imposed on the top deck of the relieving platform. This loading could have imposed excessive lateral earth pressures on the concrete seawall which, in turn, transferred the lateral load to the pile foundation. Adding to the combined stresses within the timber piles is the possibility of eccentricity due to piles which are out of plumb. To magnify the problem, soft timber is evident throughout the remaining portions of the relieving platform. This softness will reduce the ultimate capacity of the timber. Theoretically, the failure could have occurred as follows:

- 1) The top deck is loaded, causing an increase in the lateral pressures acting on the seawall.
- 2) The seawall transfers this load to the pile cap and batter piles.
- 3) Failure occurs in the pile cap adjacent to the batter pile cap (due to the combined stresses of tension and compression) allowing the relieving platform to rotate outshore. When movement begins, excessive eccentric loading occurs greatly increasing the stresses within the pile. Failure of the primary support (timber piles) then occurs.

The remaining structure appears to be in fair condition. Softness of the timber found in the older section is accounted for in the typical calculations (see Appendix A-19). The calculations indicate that there is sufficient remaining capacity within the timber piles to support current load limits. However, when combined stresses are incurred that capacity is considerably less.

Broken piles and split and displaced piles are apparently caused by excessive berthing and mooring forces transmitted through the fendering camels.

4.14.4 RECOMMENDATIONS

The 6 broken piles should be reconditioned. When they occur at the perimeter of the pier a new pile should be driven adjacent to the damaged pile, then pulled in below the existing pile cap and shimmed. Interior broken piles should be long-posted (see Appendix A-20 to A-23). The estimated cost per pile is \$1,000, the total estimated cost is \$6,000. The 3 split and displaced piles should be refastened to the pile cap or posted as needed depending upon the extent of damage (see Appendix A-20 to A-23). The estimated cost per pile is \$400, the total estimated cost is \$1,200. The damaged pile cap at Bent 85 should be repaired with a sistered cap (see Appendix A-24). The estimated cost is \$500. The 11 non-bearing and 4 partially-bearing piles should be refastened to the pile cap or repositioned below the pile cap so that full bearing is attained. The estimated average cost per repair is \$400. The estimated cost is \$6,000.

The live-load limit on the older section (circa 1914/1915) of the remaining wharf (Bents 58 to 148) should be restricted to 100 psf due to the timber softness noted. On the newer section live-loading in deck areas directly associated with damaged (broken, split and wild) piles should be restricted to 25% of the current recommended live-load capacity until those piles are repaired. Following the implementation of the recommended repairs, live-loading can be maintained at current levels (200 psf). Where the timber is in good condition there is no need to reduce the presently designated live-load of 200 psf. Dredging limits cited

in the Hudson Engineers Report of 1976 should be strictly adhered to.

In considering the reconditioning of the collapsed section or the entire wharf, an increase in the live-load capacity could be achieved in a similar manner to that used along Rowan Ave. The steel sheet pile and tie-back system could be extended to the marine railways to provide a new retaining wall with increased live-load capacity. However, precautions must be taken to provide a properly consolidated material behind the steel sheet pile wall. If this is not achieved, settlement will occur behind the sheet pile wall.

The entire existing wharf should be inspected each year for the next few years to monitor any movement in the outshore direction. It may then be decided to do less frequent inspections after that. It will also enable Shipyard personnel to monitor any other change in conditions such as timber softness. This report should be used as a baseline for future inspections.

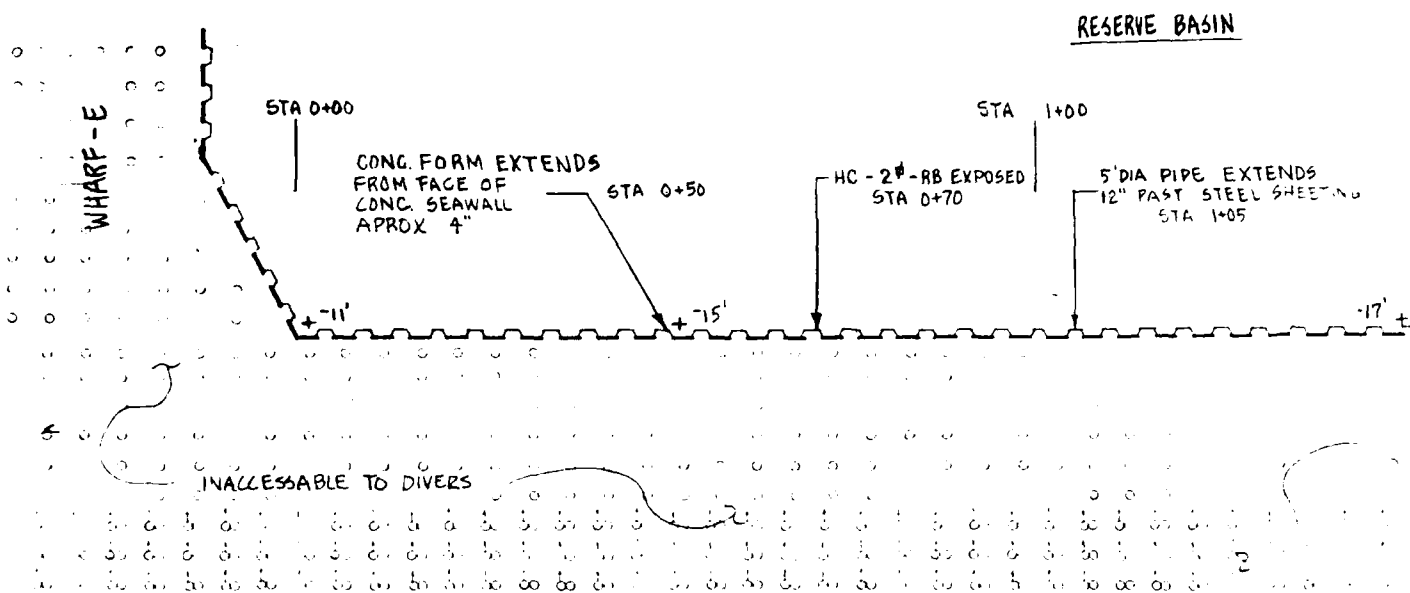
4.15 ROWAN AVENUE BULKHEAD

4.15.1 DESCRIPTION

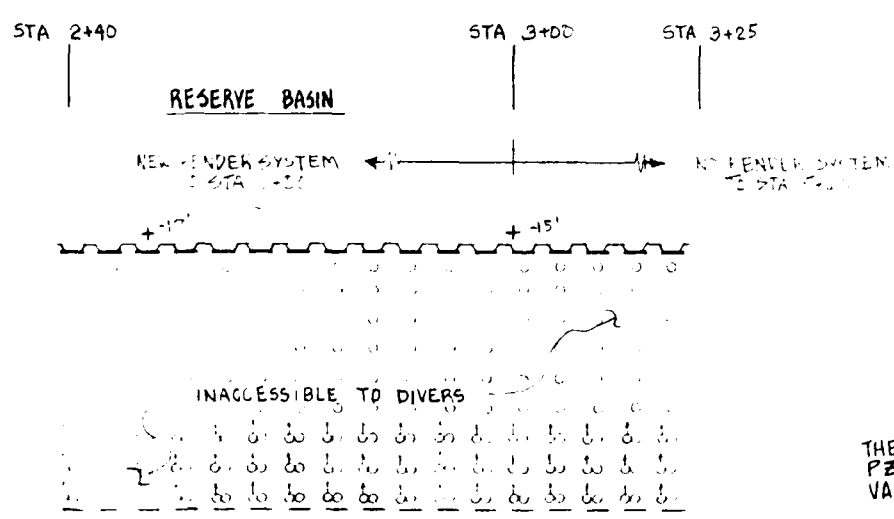
The Rowan Avenue Bulkhead is located on the southern perimeter of the Reserve Basin and is bordered by Wharf E to the west and the Second Street Wharf to the east (see Figures 4 [Vol.I] and 81-85).

The Rowan Avenue Bulkhead was originally constructed from 1904 through 1913. This structure consists of a low deck, timber pile-supported, earth fill relieving platform structure. The estimated total number of piles supporting the structure is approximately 6,500. The timber piles are assumed to have a driven capacity of 15 tons. In 1982 a steel sheet pile wall was driven across the perimeter of the structure and a tie-back system was installed. The steel sheet pile is type PZ32 with theoretical flange thickness of .500 inch and web thickness of .375 inch. Also sand fill in the form of a slurry was pumped into the area below the original relieving platform. Presently the surface live-load capacity of the structure is 600 psf. The total length of the new steel sheet pile wall is approximately 1,971 feet.

Reference 2 (see Appendix A-29)



PLAN



STEEL THICKNESS READINGS

STA 3+00		
EL (FT)	WEB (IN)	FLANGE (IN)
+2.0	.355	.545
+1.2	.350	.515
0.0	.365	.555
NL	.410	.560
THEORETICAL PZ 32 VALUE	.375	.500

PLAN

REFERENCE:
NAVJAG DWG NO. 2044119

10'
L

RESERVE BASIN

STA 1+00

HC-2#-RB EXPOSED
STA 0+70

5" DIA PIPE EXTEND
12" PAST STEEL

PLAN

STEEL THICKNESS READINGS

STA 3+00

EL (FT)	WEB (IN)	FLANGE (IN)
+2.0	.355	.545
+1.0	.350	.55
0.0	.365	.555
ML	.410	.560
THEORETICAL PZ 32 VALUE	.375	.500

REFERENCE:

NAVFAC DRAW NO. 2044-19

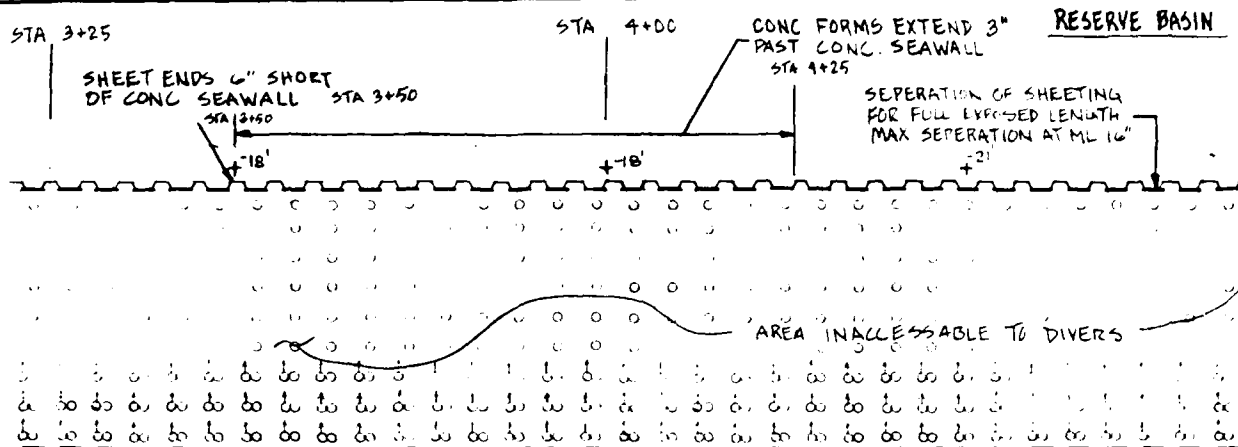
GRAPHIC SCALE

10' 0 10' 20' 30'

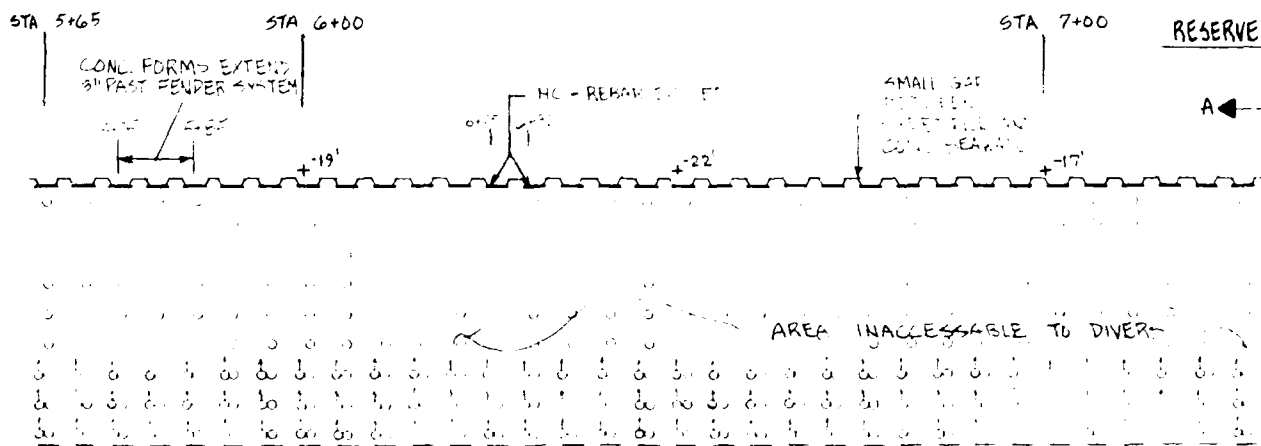
CHILDS ENGINEERING
CORPORATION
BOX 222
MEDFORD MA

CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING CENTER
MEDFORD MA 01905

ROWAN AVE 81



PLAN



PLAN

STEEL THICKNESS READINGS

STA 2+00

EL (ft)	WEB (in)	FLANGE (in)
+2.0'	.380	.545
0.0'	.350	.545
-2.0'	.345	.545
ML	.380	.540
THEORETICAL	.375	.500

PZ 32

VALUE

REFERENCE:

NAVFAC DWG NO 2049119

CONC FORMS EXTEND 3"
PAST CONC. SEAWALL
STA 4+25

RESERVE BASIN

STA 5+00

STA 5+65

SEPERATION OF SHEETING
FOR FULL EXPOSED LENGTH
MAX SEPERATION AT ML 16"

THREE DISTORTED SHEETS -
ADDITIONAL SHEETS DRIVEN
INSHORE OF THE WALL LINE
STA 5+50

STA 5+60

NEW FENDER SYSTEM

AREA INACCESSABLE TO DIVERS

PLAN

STA 7+00

RESERVE BASIN

STA 8+00

STA 8+05

SMALL GAS
PIPELINE
CROSSING UNDER
SEAWALL

LC-12 REBAR EXPOSED

A ←

AREA INACCESSABLE TO DIVERS

PLAN

A ←

LEGEND

+11' SOUNDING (FT) BELOW
MLW

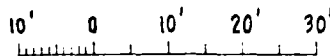
HC HONEYCOMB CONDITION
IN CONC.

5# SQUARE FEET OF AREA
EFFECTED

REFERENCE

NAVFAC DWG NO. 2044119

GRAPHIC SCALE



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NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C.

PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA

FIG NO

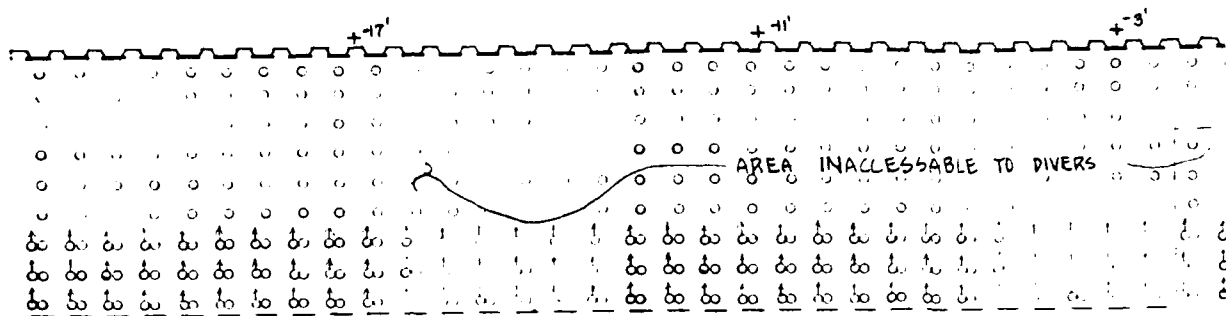
ROWAN AVE

82

STA B+05

STA 9+00

STA 9+57

RESERVE BASINSTEEL THICKNESS READINGS

STA 9+00		
EL (ft)	WEB (in)	FLANGE (in)
+2.0	.385	.530
0.0	.366	.535
-2.0	.390	.530
ML	.366	.555
THEORETICAL P&Z2 VALUE	.375	.500

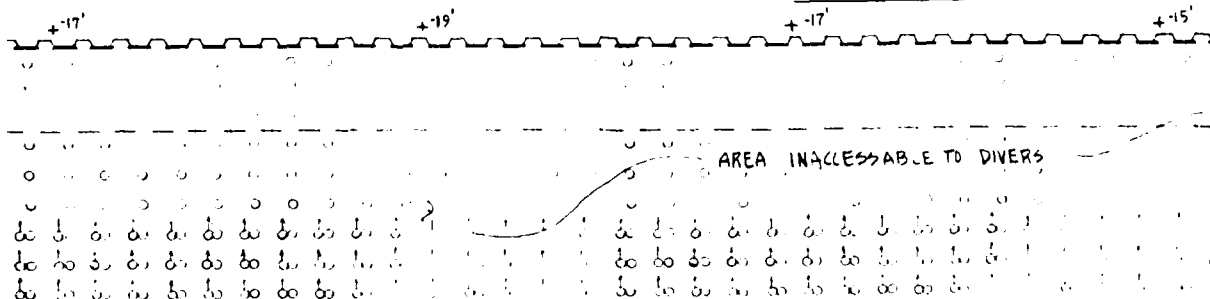
STA 12+00		
EL (ft)	WEB (in)	FLANGE (in)
+2.0	.380	.525
0.0	.380	.525
-2.0	.385	.525
ML	.390	.535

PLAN

STA 10+47

STA 11+00

STA 12+00

RESERVE BASINLEGEND+11' SOUNDING (ft) BELOW
MLWHC HONEYCOMB CONDITION
IN CONC.59 SQUARE FEET OF AREA
EFFECTEDPLANREFERENCE
NAVFAC DWG NO 2044119

STA 9+00

STA 9+57

STA 10+00

STA 10+47

RESERVE BASIN

HC-2⁰-REBAR EXPOSED
STA 10+40

+11'

+3'

+12'

AREA INACCESSIBLE TO DIVERS

N



STA 12+00

FLANGE (in)

PLAN

80 525

80 525

80 525

80 525

80 535

CONC FORMS EXTEND TO
THE FACE OF THE FENDER
SYSTEM

STA 12+00

STA 12+87

RESERVE BASIN

+17'

+15'

+6'

AREA INACCESSIBLE TO DIVERS

SEPERATION OF SHEETING FOR
FULL EXPOSED LENGTH -
MAX SEPERATION AT STA 12+40

NOTE:
LOSS OF FILL DETECTED
AT STA 12+00

PLAN

REFERENCE
NAVFAC DWG NO. 2044119

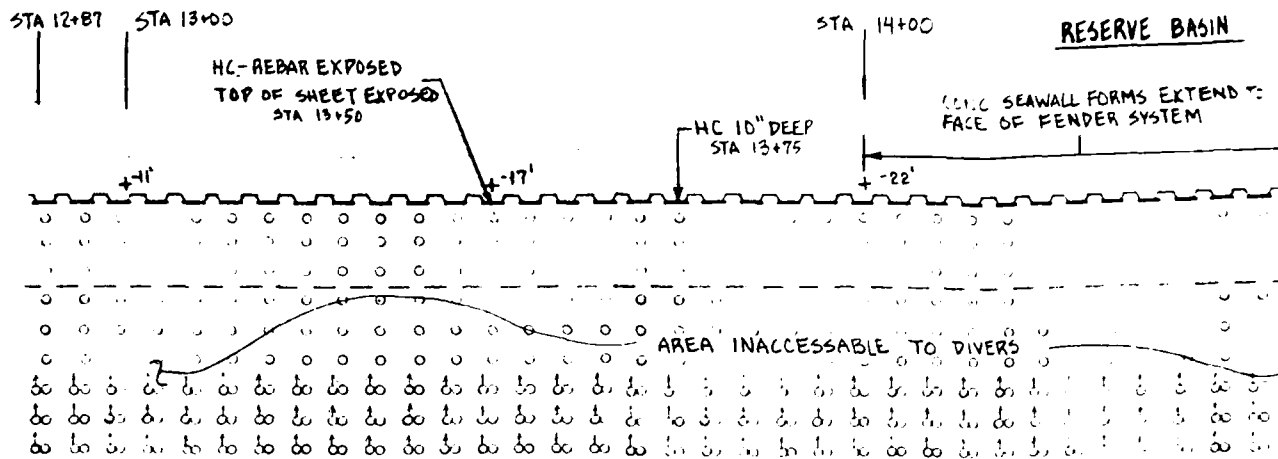
GRAPHIC SCALE

10' 0' 10' 20' 30'

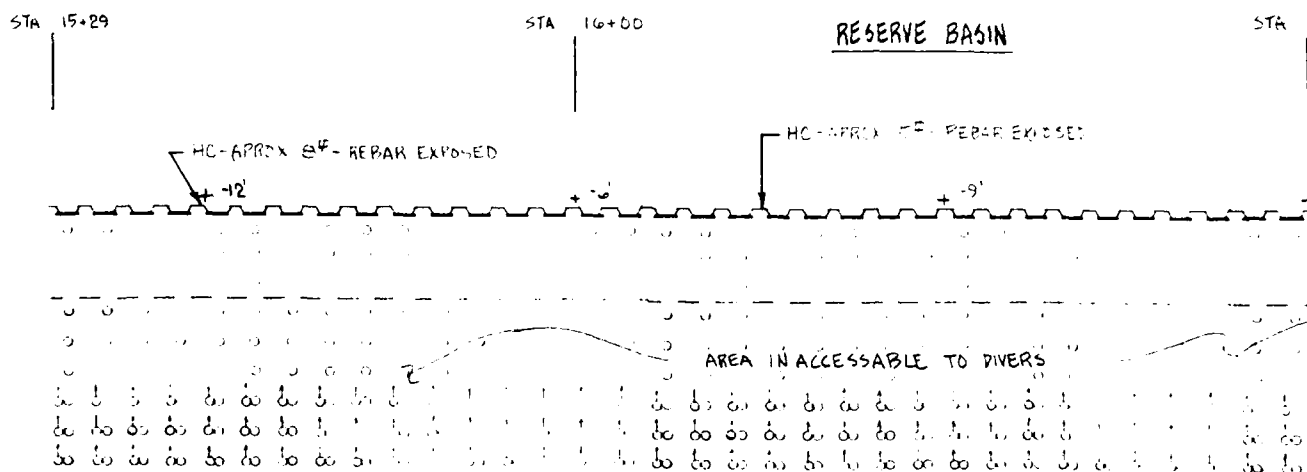
CHILDS ENGINEERING
CORPORATION
804 333
MEDFIELD, MA

CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C.
PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA
ROWAN AVE

FIG NO
83



PLAN



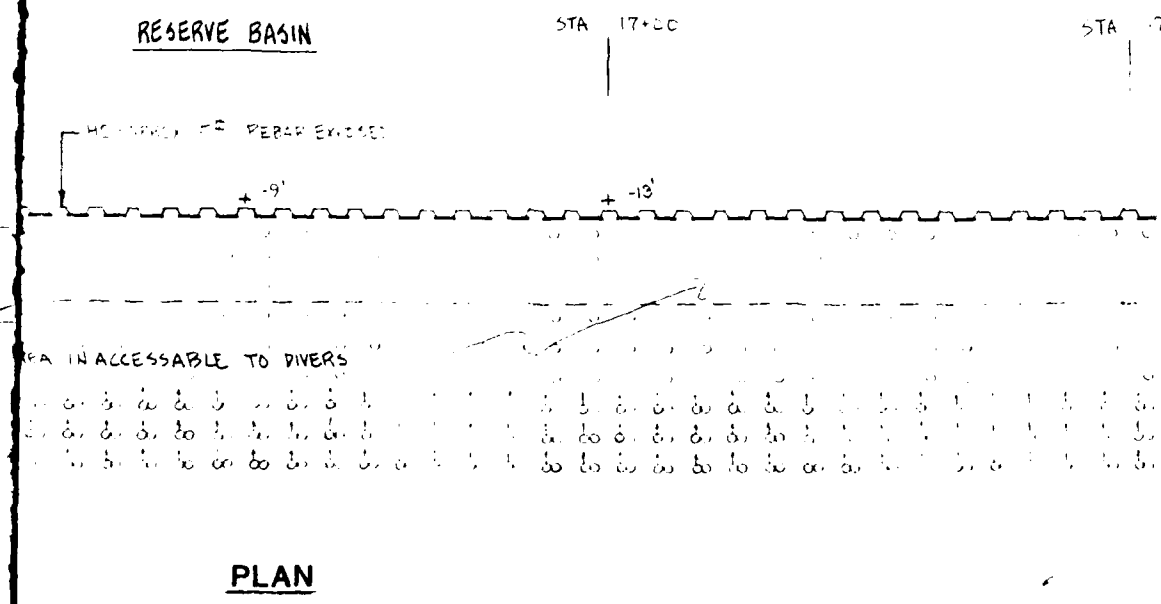
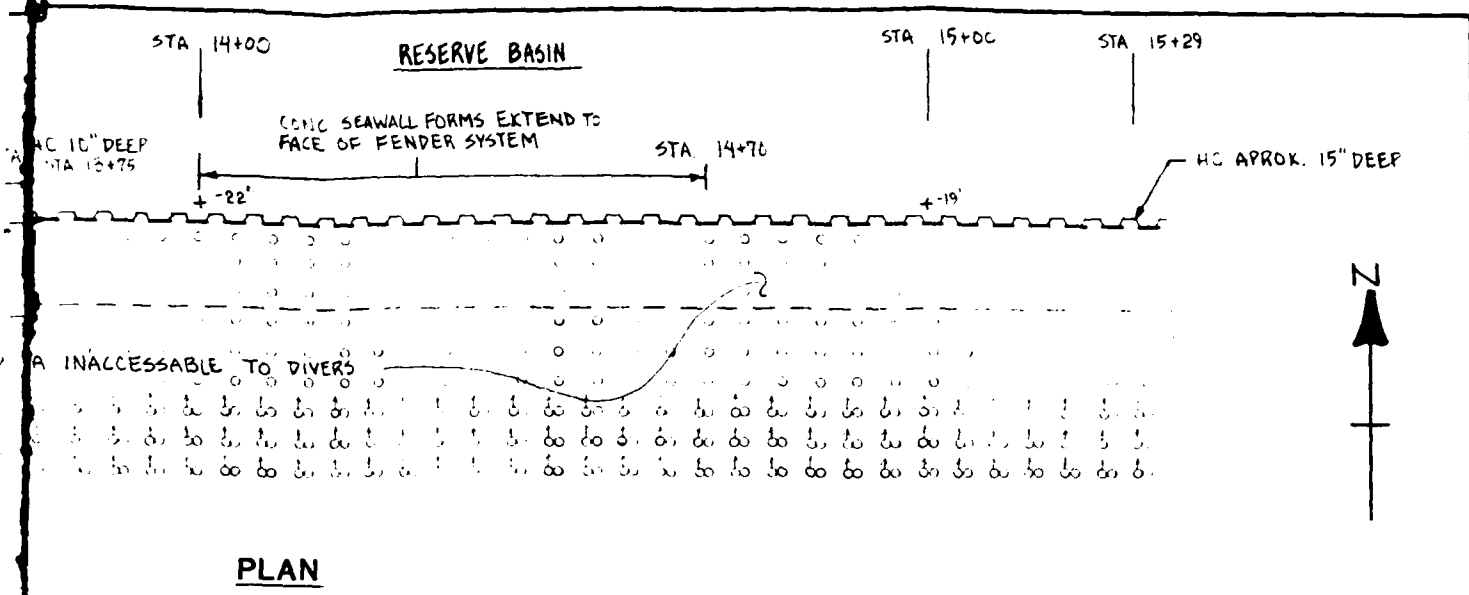
PLAN

STEEL THICKNESS REQUIREMENTS

EL (ft)	WEB (in)	FLANGE (in)
+2.0	.465	.570
0.0	.376	.545
-2.0	.375	.560
ML	.405	.580
THEORETICAL PZ 32 VALUE	.375	.500

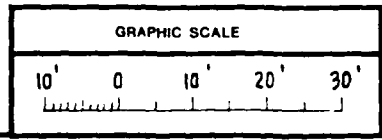
REFERENCE:
NAVFAC DWG NO. 2044119

10'
1" = 10'



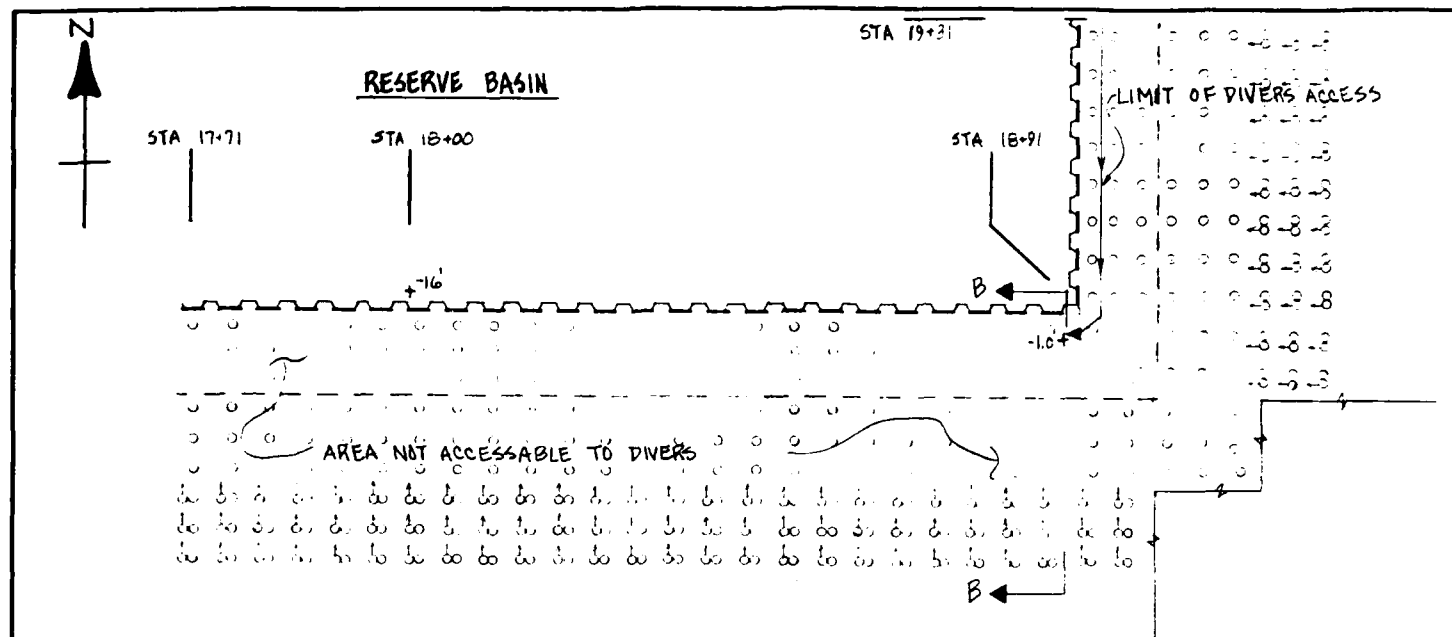
- LEGEND
- +11' SOUNDING (FT. BELOW MLW)
 - HC HONEYCOMB CONDITION IN CONC.
 - 5# SQUARE FEET OF AREA EFFECTED

REFERENCE:
NAVFAC DWG NO. 2044119

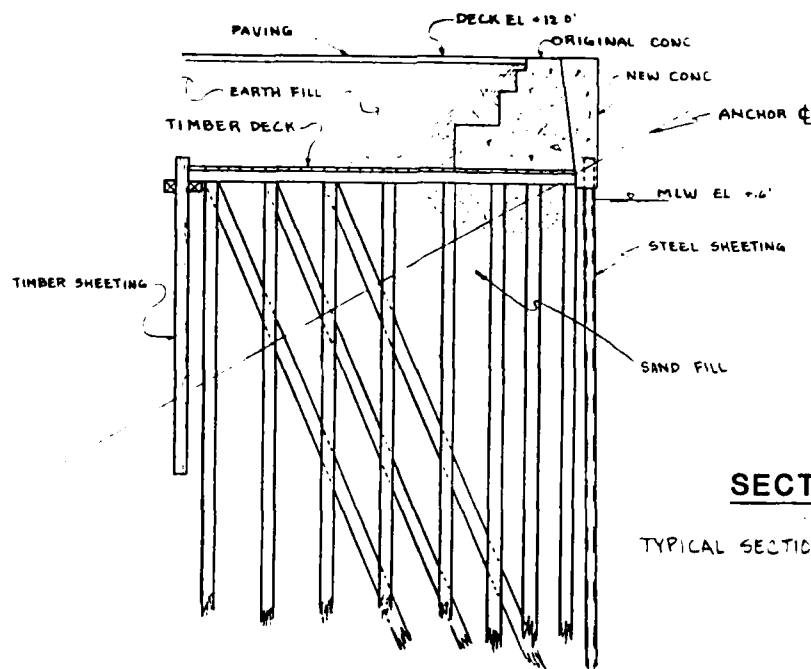


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CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON D.C.	
PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA	FIG NO
ROWAN AVE	84



PLAN



STEEL THICKNESS

EL (FT)	STA 18+ WEB (IN)
+2.0	.410
0.0	.370
-2.0	.370
ML	.410
THEORETICAL PZ 32 VALUE	.375

SECTION A-A

TYPICAL SECTION STA 7+0 THRU STA 9+51

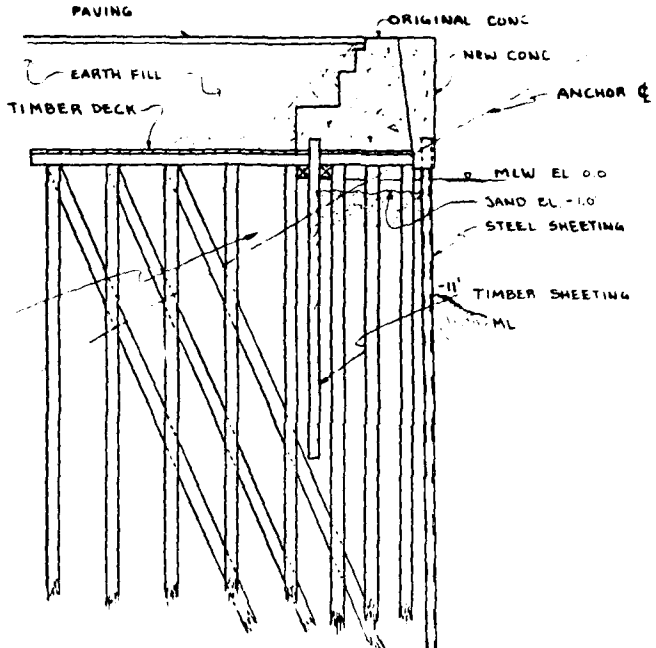
STA 19+31

STA 18+91

LIMIT OF DIVERS ACCESS

-1.0'

B



SECTION B-B

TYPICAL SECTION STA 9+57 THRU STA 18+91

STEEL THICKNESS READINGS

STA 18+00

EL (FT)	WEB (IN)	FLANGE (IN)
+2.0	.410	.570
0.0	.370	.540
-2.0	.370	.540
ML	.410	.565
THEORETICAL PZ 32 VALUE	.375	.500

LEGEND

- +7' SOUNDING (FT) BELOW MLW
- HC HONEYCOMB CONDITION IN CONC.
- 5# SQUARE FEET OF AREA EFFECTED

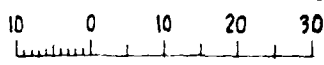
REFERENCE

NAVFAC DWG NO. 2044119

SECTION A-A

TYPICAL SECTION STA 7+0 THRU STA 9+51

GRAPHIC SCALE



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NAVAL FACILITIES ENGINEERING COMMAND

WASHINGTON, D.C.
PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA

ROWAN AVE

FIG NO

85

4.15.2 OBSERVED INSPECTION CONDITION

Along the face of the new concrete portion of the seawall there are locations where voids or honeycombs occur in the concrete at MLW. This honeycombing is usually only 2" to 3" deep, although occasionally it does reach a maximum depth of 10". Associated with this honeycombing is the exposure of reinforcing steel to the marine environment. Specific locations of honeycombing can be found on Figures 81 through 85.

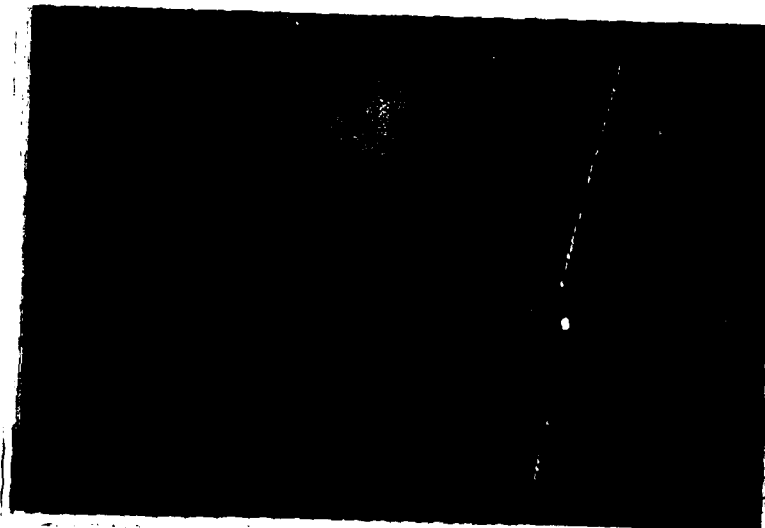
The formwork previously used in the construction of the seawall remains in place along most of the seawall. Although the majority of the formwork does not protrude from the face of the concrete, in locations noted on Figures 81, 82, 83 and 84, the steel form does extend 3" to 10" from the face of the concrete. In one location, station 5+75, the steel form extends past the fender system approximately 3", for a length of 10'.

In three locations, stations 4+75, 5+50, and 12+60 along Rowan Avenue, the steel sheet piles are separated. The largest gap between the mis-driven sheeting is 16" at the mudline at station 4+75, (see Photos #57 and #58). The smallest is 8" at the ML at station 12+60. At station 5+50, there is a sheet separation which has been repaired by driving additional sheet piles directly inshore of the separation, (see Photo #59). Access to the fill material behind the sheeting could be gained through the other separations. There is no distinct evidence of large quantities of fill material (sand) leaching through the separations in the sheeting.



PHOTO NO. 57: Rowan Ave., Sta. 4+75, El. -16;
split knuckle of sheet pile with
backfill exposed. Split is approx.
10" wide.

PHOTO NO. 58: Rowan Ave., Sta. 4+75, El. -21;
split knuckle of sheet pile with
backfill exposed. Split is approx.
12" wide.



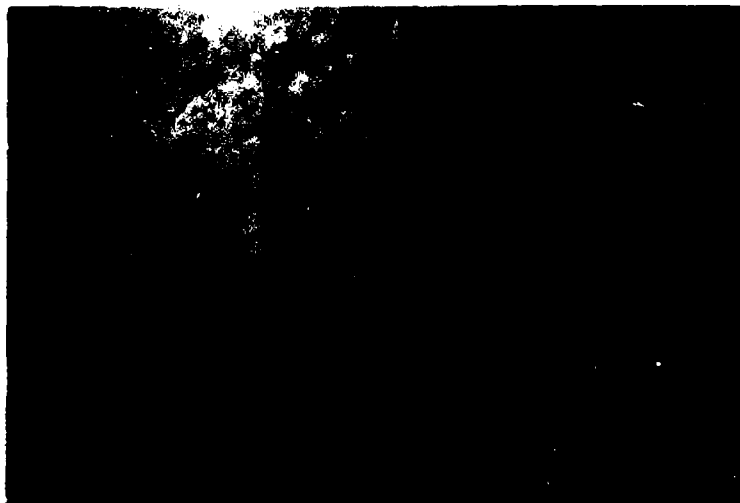


PHOTO NO. 59: Rowan Ave., Sta. 5+50; distorted steel sheet piles. Note $1/4''$ - $3/4''$ orange corrosion nodes on steel sheet piles. Repair of distorted sheets was made by driving additional sheeting behind the sheet piles shown.

Ultrasonic steel thickness measurements taken on the sheet piles indicate that there has been no loss of steel section due to corrosion.

The relieving platform behind the sheet pile wall generally could not be accessed by the divers. The only accessible area behind the sheeting was at the junction of the Second Street Wharf. Access was gained to the corner of the steel sheet piling from below the relieving platform. Sand fill was detected approximately 20' from the corner to the north and was sloping up to the south, where at the corner, the elevation of the sand was approximately 3' below the timber deck (El. -1.0').

4.15.3 STRUCTURAL ASSESSMENT

The honeycomb condition of some sections of the lower face of the concrete seawall does not threaten the overall structural integrity of this facility. However, this condition does invite accelerated rates of deterioration such as spalling of the concrete and corrosion of the rebar.

The concrete forms which protrude from the face of the seawall have the potential to cause damage to ships which berth along the Rowan Avenue Wharf. However, the fender system will provide some protection to berthing ships, except in the location where the form extends past the fender system (see Figure 82) at Sta. 5+75.

Separation of the steel sheet piles will not effect the overall structural integrity of the sheet pile wall, i.e., catastrophic failure. Although in the area of a sheeting separation, there is the potential for the loss of fill material, therefore creating a void space behind the sheet pile wall. In reviewing the Rowan Avenue repair drawings, it is apparent that the concept in design was to transfer the dead load and live load imposed on Rowan Avenue to the sand fill material which was pumped in below the original relieving platform structure. This sand fill is retained by the steel sheet pile wall. If void spaces occur directly below the relieving platform, then the relieving platform is existing as the primary support structure while the sand fill and steel sheet piling are not directly contributing to the support of the structure.

Void spaces between the relieving platform and the sand fill can occur due to sheet separation or could potentially be caused by subsidence of the sand due to inadequate compaction.

The sinkholes are caused by the movement of the underlying strata (the relieving platform's earth fill) to a void space below the relieving platform. This will cause depressions or voids beneath the top deck surface. The void may lie undetected until a load is imposed on the deck paving with the result being a collapse of the paving.

According to the condition survey submitted by Hudson Engineers in 1976 there was an apparent problem with the deck timber in that portion of the Rowan Ave. Bulkhead about the old Pier D. Softness of the deck timber was reported along with some localized failure of the timber decking. Apparently these reported conditions prompted the repairs which were installed in 1982.

The problematic condition which is present along the Rowan Ave. Bulkhead is caused by a combination of events. In some locations it appears the relieving platform is acting as the primary structure. The timber decking is soft and unable to support its dead load, therefore resulting in localized deck timber failure. The earth fill supported by the relieving platform is then being transported through the openings in the deck, caused by deck timber failure, and being placed below the relieving platform. The void that is left behind by the movement of earth fill is then realized in the form of settlement of the surface paving.

4.15.4 RECOMMENDATIONS

The honeycomb condition which occurs along the lower portion of the seawall should be patched with pneumatically-placed concrete in order to provide the proper cover for the reinforcing steel. The estimated cost to cover 1 square foot of surface area is \$14.16. There is an estimated 50 sq.ft. of area in need of repair. The total estimated cost of repair is \$700 plus mobilization and demobilization.

The steel formwork which protrudes from the face of the concrete should be cut back flush with the face of the concrete seawall. The estimated lump sum cost to trim the steel forms is \$3,000.

There are three locations where there is an unrepaired sheet separation that should be repaired (Sta. 4+75, 5+50 and 12+60). A steel plate should be welded across two adjacent flanges bridging the gap between the sheets. The steel plate should be pushed into the bottom to a sufficient depth as to close off any escape route possibly available to the retained fill material. The steel plate should extend up to the concrete. The estimated cost to patch one gap is \$2,000. To patch three gaps, the estimated cost is \$6,000.

To investigate the problem of sinkholes occurring along Rowan Ave., the first step would be to take borings through the relieving platform at various locations. The boring logs would enable base personnel to determine to what extent the sand fill is acting as a structural element in supporting the timber deck. If the deck is

not bearing on the sand or the sand is not effectively consolidated, then the load above the decking is being supported by the deck timber and the sand is ineffective as a primary structural element. The estimated cost to take 12 borings would be \$4,000.

A more cost effective method of determining properties of the sand below the relieving platform would be to dig a test pit above the relieving platform to expose the timber decking. A section of the timber deck could then be removed and the sand below could be observed and sampled. The level of the sand should be flush with the lower side of the timber decking for it to be an integral part of the support structure. An inspection of the timber decking could also be made at this time.

The flume associated with the old Pier D (Flume "A" per NAVFAC Dwg. No. 2044119) should be investigated for possible areas where loss of fill may occur.

Upon completion of the recommended repairs and return of satisfactory results of the detailed investigation, the live-load capacity (600 psf) of the bulkhead should not be reduced. The estimated future life of the steel sheet pile structure is in excess of 20 years.

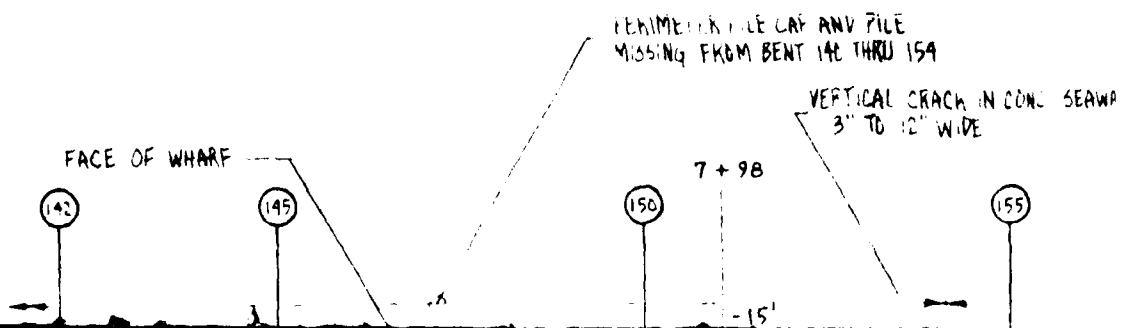
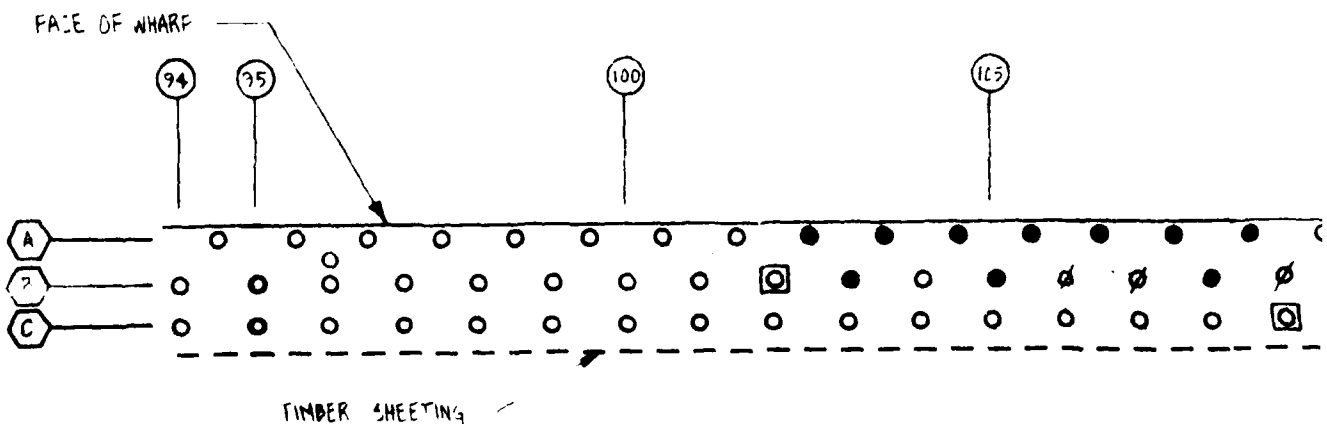
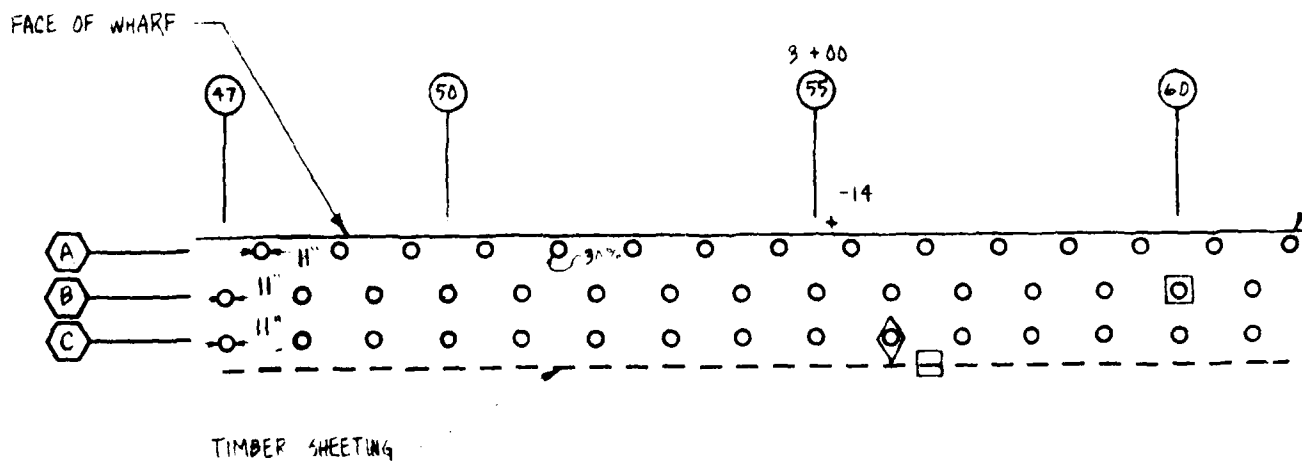
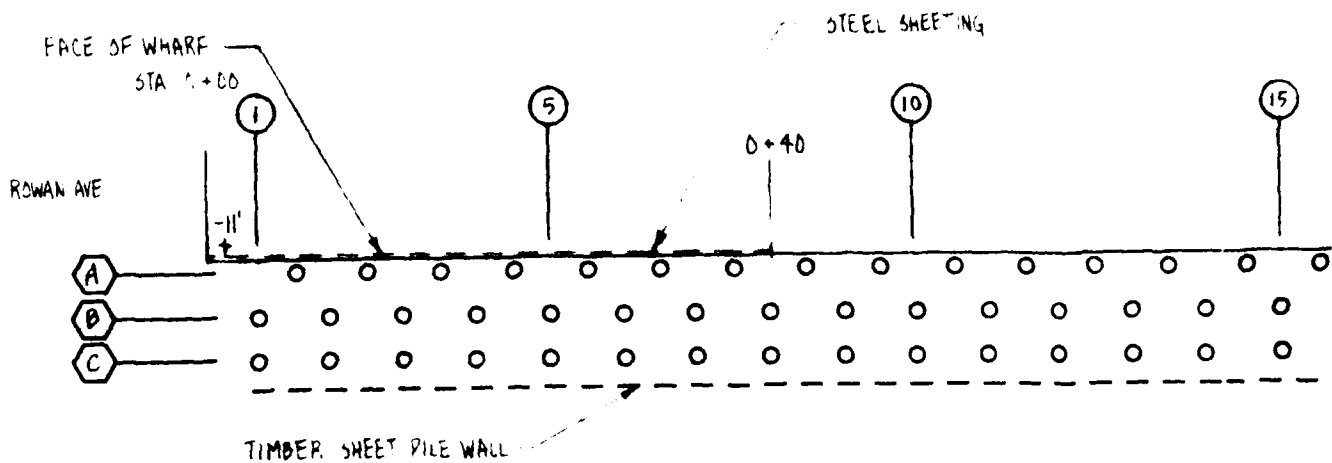
The entire wharf should be re-inspected after repairs and in 6 years thereafter. This will enable Shipyard personnel to determine corrosion profiles and possibly establish a rate of corrosion. This report should be used as a baseline for future inspections.

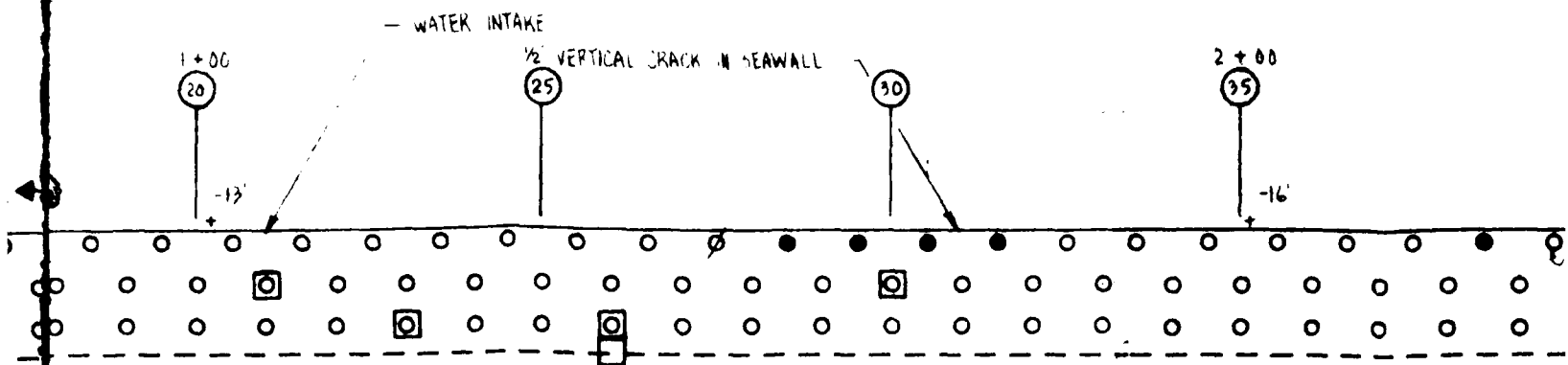
4.16 SECOND STREET WHARF

4.16.1 DESCRIPTION

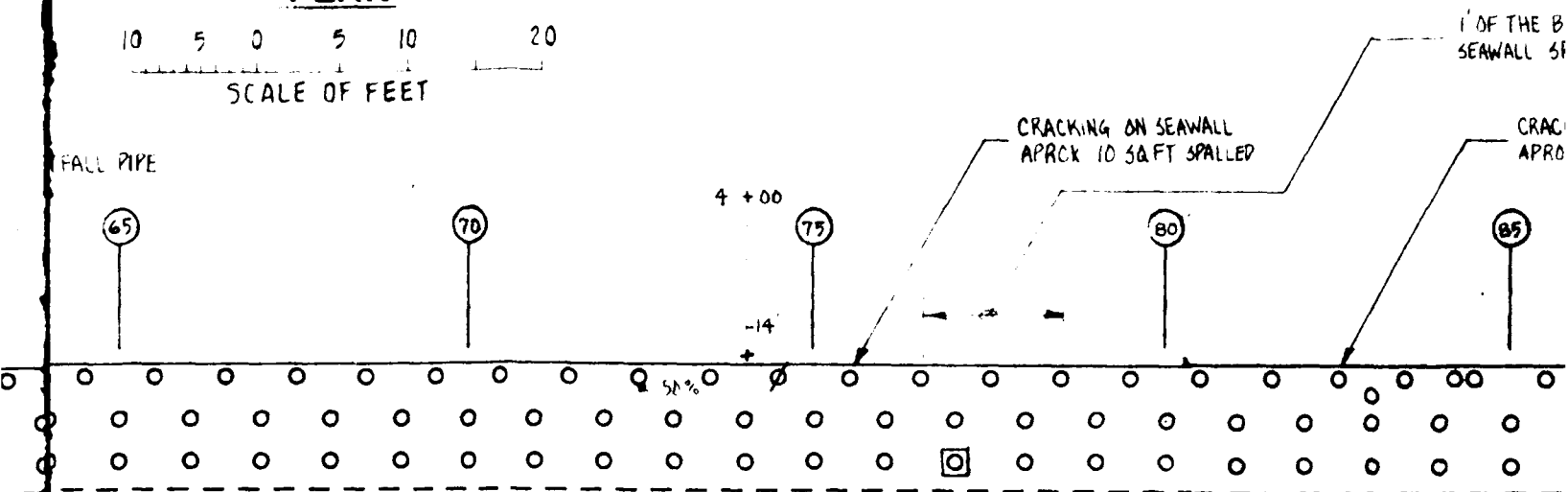
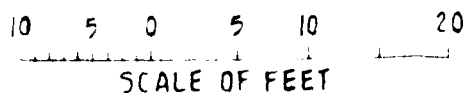
The Second Street Wharf is located on the eastern side of the Reserve Basin to the north of Rowan Avenue and to the south of Preble Avenue, (see Figures 4 [Vol. I] and 86). The timber pile-supported, low deck, earth-filled structure was constructed circa 1902-1903. The total length of the wharf is 928'. There are approximately 528 accessible vertical piles arranged in 2-pile bents 5' on center with pile clamps. There is an additional row of piles spaced 5' on center in a staggered position with respect to the pile bents. The additional row of piles has a longitudinal pile cap and forms the perimeter of the pier (see Figure 86). Approximately 10' inshore of the face of the pier there is a timber sheet pile wall extending from the timber deck to the river bottom. The earth fill placed above the timber deck is retained by a concrete seawall. The top deck elevation is +12'. The assumed bearing capacity of the vertical piles is 15 tons. Presently, the allowable loading on the top deck is 200 psf. During the inspection the Second St. Wharf was functioning as a permanent mooring for inactive self-propelled lighters.

Reference 2 (see Appendix A-29)

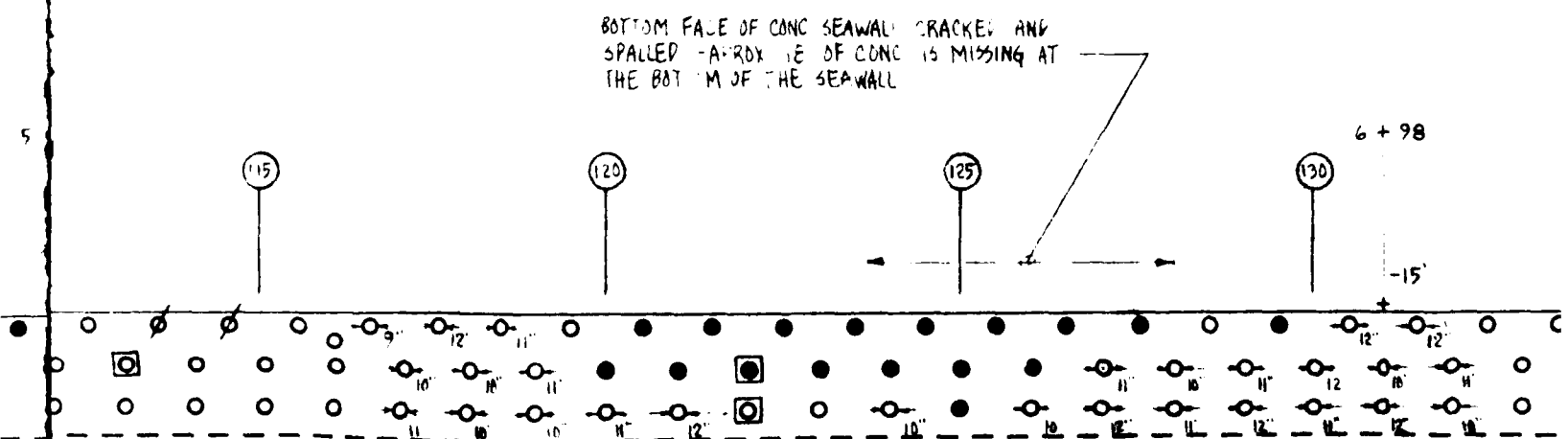




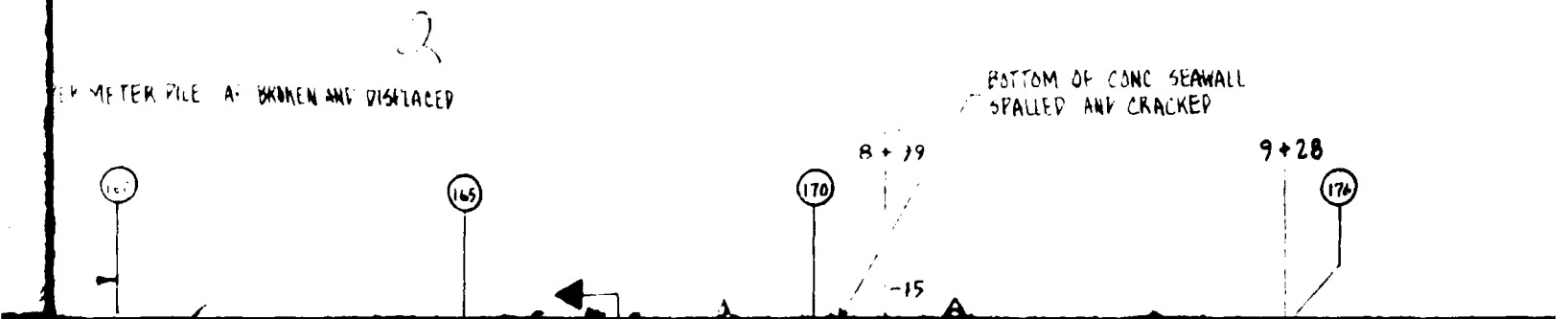
PLAN

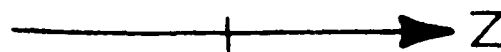


PLAN



PLAN





ON CAIRING ON SEAWALL
SQ EX 8 SQ FT SPALLED



-14-

1. LEVEL 1 INSPECTION ON ALL PILES-HIGHER LEVELS OF INSPECTION WHERE NOTED.

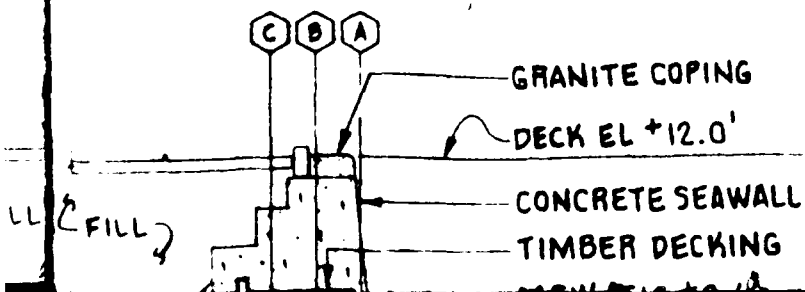
2. CORE SAMPLES INDICATE 1 1/2" OF SOFTNESS,
A TYPICAL CONDITION.

3. REFERENCE: HUDSON ENGINEERS SURVEY-1976
SHT 14, PW DWG NOS. B-1797
& B-1798.

PERIMETER P.E. CAP MISSING AND POWER I OF
CONC SEAWALL BROKEN AWAY BENT 39-154



DISCHARGE PIPE

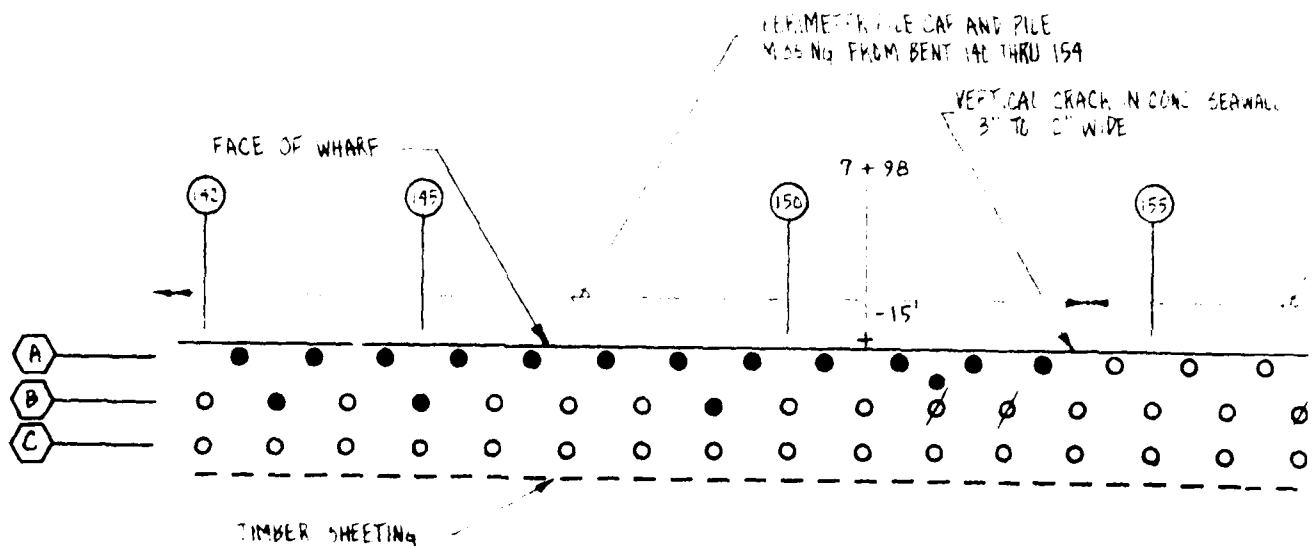
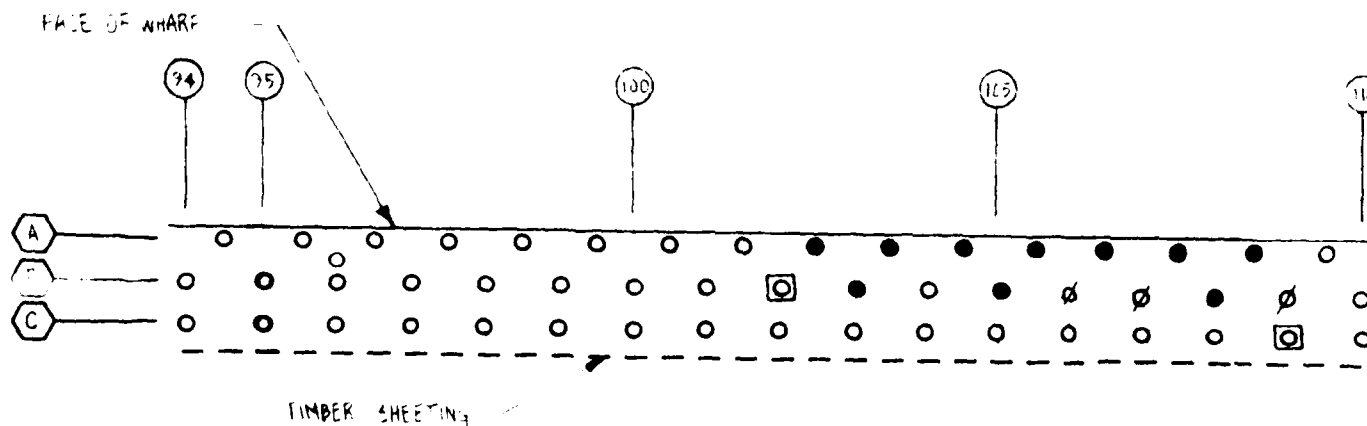


-GRANITE COPING

DECK EL +12.0'

CONCRETE SEAWALL

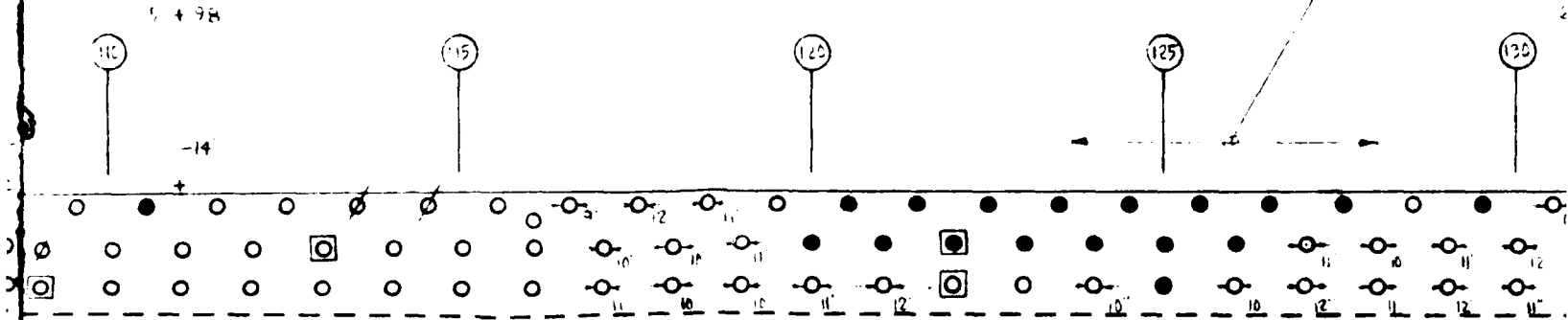
TIMBER DECKING



LEGEND

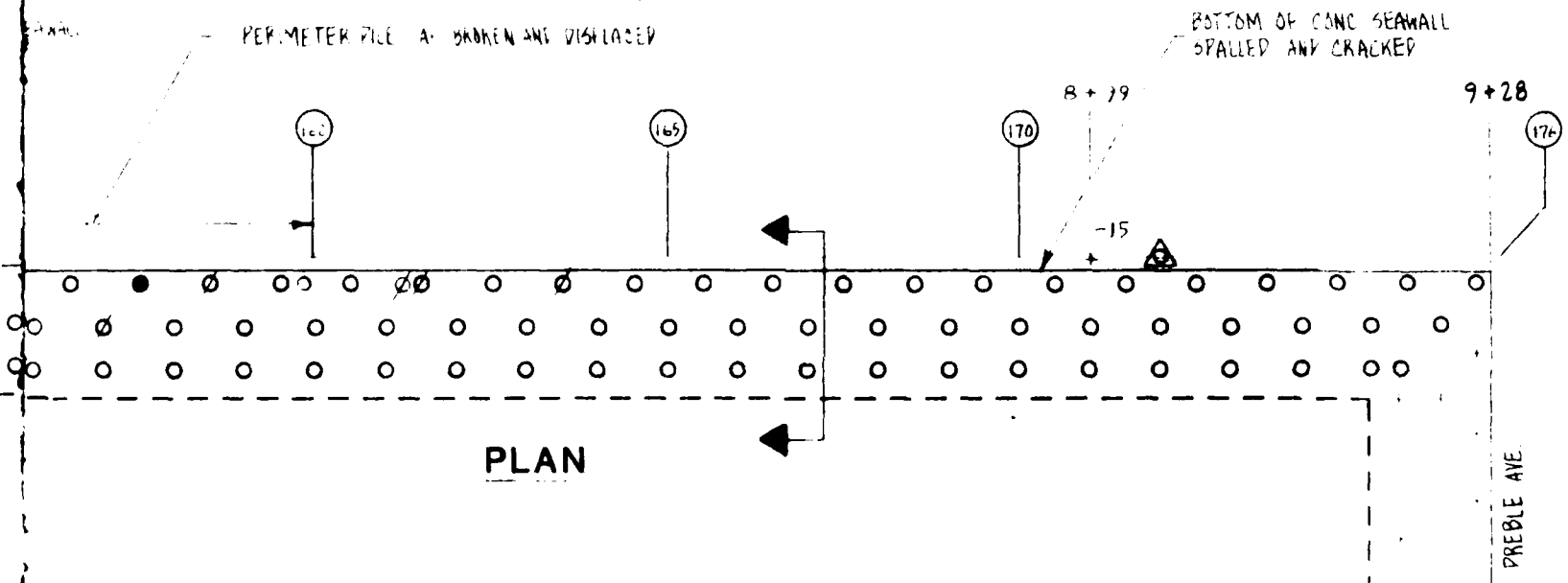
- WILD PILE
- NON-BEARING PILE
- BROKEN PILE
- DISPLACED-SPLIT PILE
- CORE LOCATION (PILE, CAP, DECK) LEVE
- MINIMUM PILE DIAMETER, LEVEL 2 IN
- SOUNDINGS IN FEET BELOW MLW
- 50% OF PILE BEARING ON PILE CAP
- TIMBER BEARING PILE
- TIMBER BATTER PILE
- BENT NO. DESIGNATION
- PILE DESIGNATION

BOTTOM FACE OF CONC SEAWALL CRACKED AND
SPALLED - A BOX E OF CONC IS MISSING AT
THE BOTTOM OF THE SEAWALL



PLAN

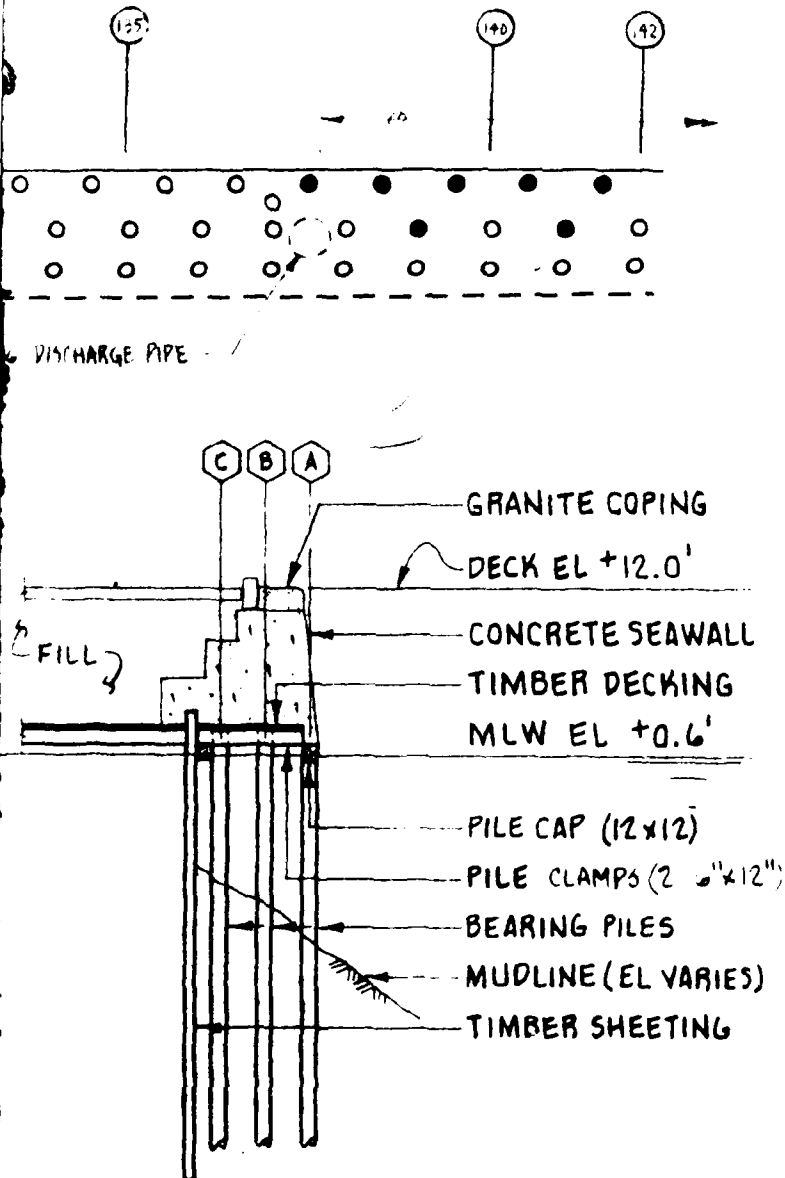
2



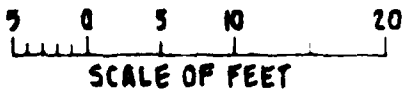
PLAN

LEVEL 3 INSPECTION
LEVEL 2 INSPECTION

PERIMETER PILE CAP MISSING AND DWEEL OF
 CONCRETE SEAWALL BROKEN AWAY BENT 59-154



SECTION A-A



GRAPHIC SCALE

AS SHOWN

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 CORPORATION
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 MEDFIELD, MA

CHESAPEAKE DIVISION
 NAVAL FACILITIES ENGINEERING COMMAND
 WASHINGTON, D.C.

PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA

SECOND ST. WHARF

FIG. NO.

86

4.16.2 OBSERVED INSPECTION CONDITION

Quantities of specific anomalies detected which relate to the structural piles are listed as follows:

- 57 - Broken piles
- 15 - Split and displaced piles
- 1 - Non-bearing pile
- 1 - Wild pile
- 3 - Partially-bearing piles

These anomalies can be located on Figure 86.

Core samples of the structural timber piles indicate that there is softness to a depth of 3" in some timber piles. Typically, the softness is 1-1/2". Minimum pile diameters range from 9" to 12". The timber pile clamps and decking are in sound condition. The timber sheet pile wall is also in sound condition although minor gaps between sheets were found (see Photo #60 for typical algal growth).

The concrete seawall is showing some signs of deterioration. In various locations there are vertical cracks ranging in width from hairline to 12" wide. Corresponding to locations where there are large numbers of broken perimeter piles, the lower outshore corner of the concrete seawall has either broken or spalled away (see Appendix A-26). Associated with this damage to the seawall is deterioration of the longitudinal pile cap.

Fasteners used to connect the pile clamps to the piles appear to be slightly corroded with approximately 10-15% loss of steel.

The fender system is generally non-functional throughout most of the length of the wharf.



PHOTO NO. 60: Second St. Wharf, Bent 98, Pile A;
illustrates typical algal growth.

4.16.3 STRUCTURAL ASSESSMENT

The broken or split piles found in various concentrations along the wharf were apparently caused by excessive forces transmitted by fendering camels. The forces transmitted by a camel typically originate from the berthing and mooring forces of ships. The loss of concrete from the lower portion of the seawall is attributed to these excessive forces. Settlement of the seawall in some locations appears to be related to the absence of support due to the broken piles.

There has been no change in the cross-sectional area of the timber piles since they were driven. However, softness of the timber piles found throughout the wharf indicates that a reduction of the minimum pile diameter is necessary in the calculation of the pile's column capacity (see Appendix A-11). Assuming a reduced minimum diameter of 7", the column capacity is 19 tons, which is greater than the 15 tons driven capacity, therefore the driven capacity is the limiting factor. The pile foundation is capable of supporting its designed loading based on an assumed maximum area of 16 sq. ft. supported by one bearing pile. Calculations indicate that where there has been no mechanical damage, the live-load capacity need not be reduced due to timber softness.

Although gaps were detected along the timber sheet pile wall there were no large quantities of fill leaching out from behind the wall. This condition at this time does not present a problem.

4.16.4 RECOMMENDATIONS

The 57 broken piles should be replaced. New creosoted timber piles should be driven adjacent to the broken perimeter piles and sprung in under the longitudinal pile cap. The interior piles which are broken should be long-posted. The estimated cost per pile is \$1,000, the total estimated cost is \$57,000. Where the longitudinal pile cap is damaged or missing it should be replaced. Where the concrete seawall is broken away, full bearing should be attained on the pile cap. There are approximately 150 lineal feet of pile cap that should be replaced. At an estimated cost of \$5/bd.ft. in place, the total estimated cost is \$9,000. The 20 split and displaced, non-bearing, wild and partially bearing piles should be repositioned and refastened to the pile cap or clamp. At an estimated cost of \$400/pile, the total estimated cost is \$8,000. Conceptual repair details can be found in Appendix A-20 to A-27.

If the wharf is to be used as a mooring for inactive ships and berthing/mooring forces are expected, a fender system should be installed and the use of camels should be discontinued.

Prior to completion of repairs live-loading should be restricted in areas where piles are missing. Upon completion of the recommended repairs, the previously-designated live-load capacity of 200 psf on the top deck should not be downgraded. The estimated future life of the Second St. Wharf is in excess of 10 years. The entire wharf should be re-inspected in 2 years. This will enable Shipyard personnel to determine any change in conditions. This report should be used as a baseline for future inspections.

4.17 PREBLE AVENUE WHARF

4.17.1 DESCRIPTION

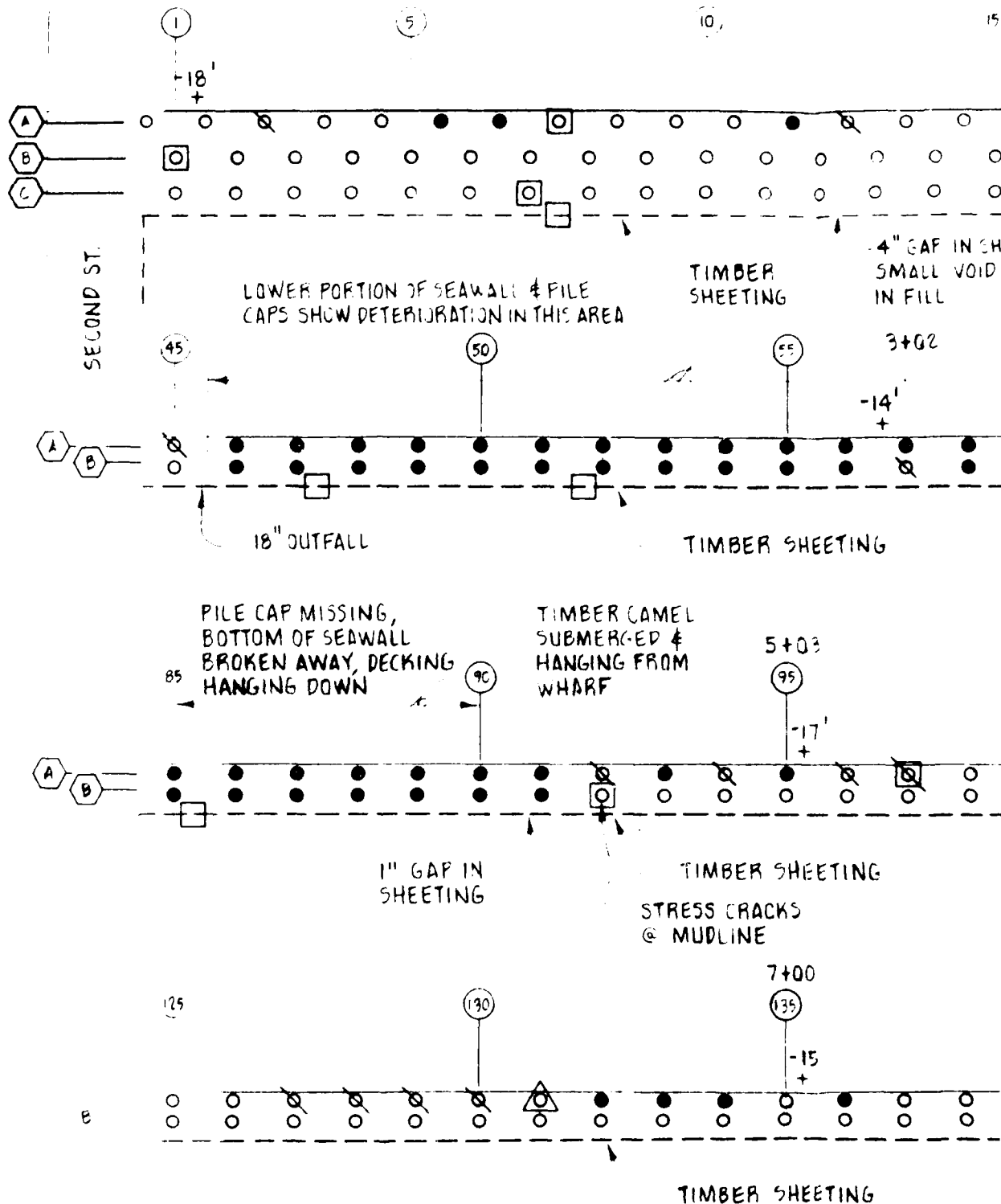
The Preble Avenue Wharf runs east and west and is located at the eastern end of the Reserve Basin, (see Figures 4 [Vol. I] and 87). To the west it ends at Second Street and to the east it is bordered by Broad Street. The low deck, earth-filled, timber pile-supported, relieving platform structure was constructed Circa 1900. The wharf is approximately 847' long and has 370 accessible piles. The piles in the first 40 bents are arranged in 2-pile bents with an extra row of staggered piles outshore of the first bent pile. At Bent 40 the configuration changes to just a 2-pile bent arrangement. The timber sheet pile wall runs along the last accessible pile in each bent, approximately 5'-10' inshore of the face of the wharf. The earth fill placed above the timber deck is retained by a concrete seawall. The top deck elevation is +12'. The assumed bearing capacity of the bearing piles is 15 tons. Presently the allowable live-loading on the top deck is 200 psf. During the inspection the Preble Avenue Wharf was a permanent mooring for various inactive ships.

Reference 2 (see Appendix A-29)

STATIONING (TYP)

0+00

15



PILE CAP HIT
& ROTATED

FACE OF WHARF

+97

2+02

(20)

(25)

(30)

(35)

-12'
+

PLAN

PILE CAP
MISSING

FACE OF WHARF

OUTFALL

3+99

PILE CAP &
CONC SEAWALL
DAMAGED

PLAN

LOWER PORTIONS OF SEAWALL
AND PILE CAPS ARE DETERIORATED
IN THIS AREA

FACE OF WHARF

6+00

CONCRETE
SEAWALL
SPALLED 6"
@ BOTTOM

PLAN

FACE OF WHARF

8+00

CONCRETE SEAWALL
SPALLED 2"
@ BOTTOM

CONCRE
SEAWALL
SPALLED
@ BOTTO

PLAN

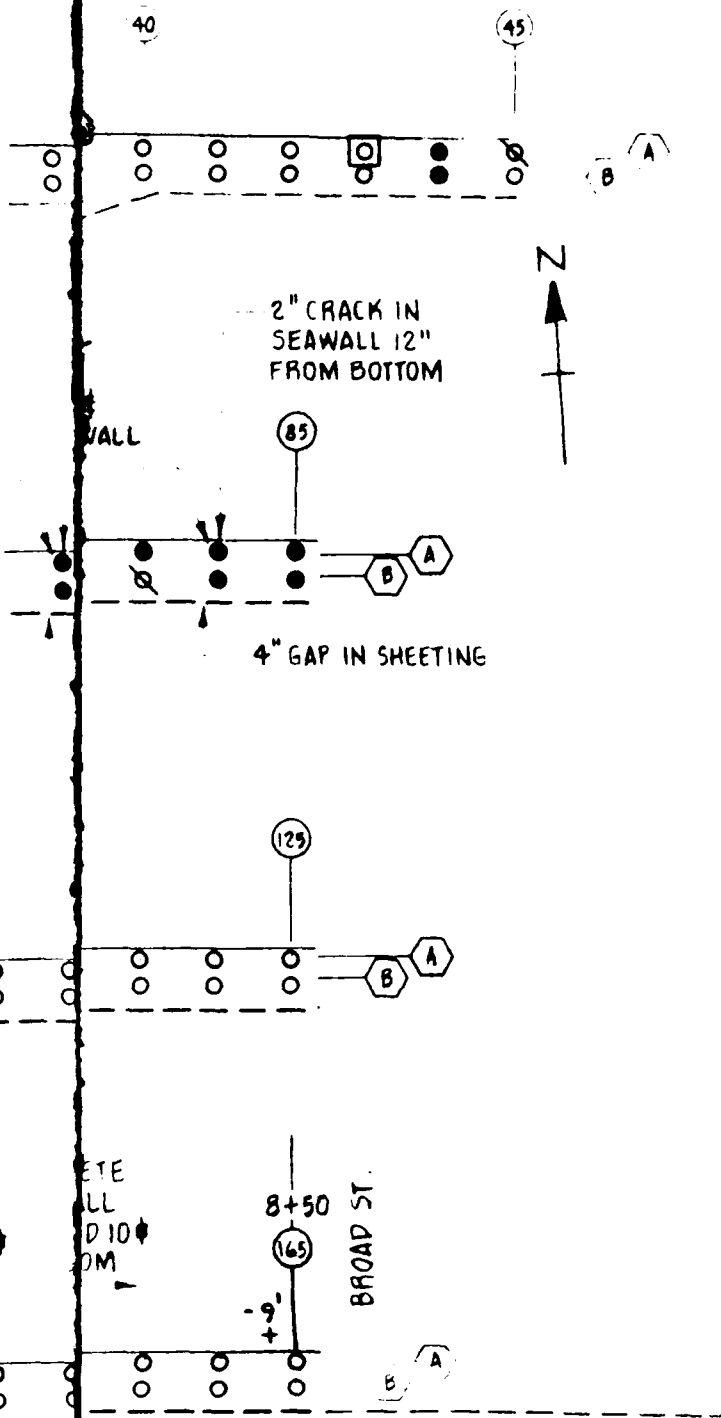
4" GAP IN SHEETING

GRANITE COPING

DECK EL +12.0'

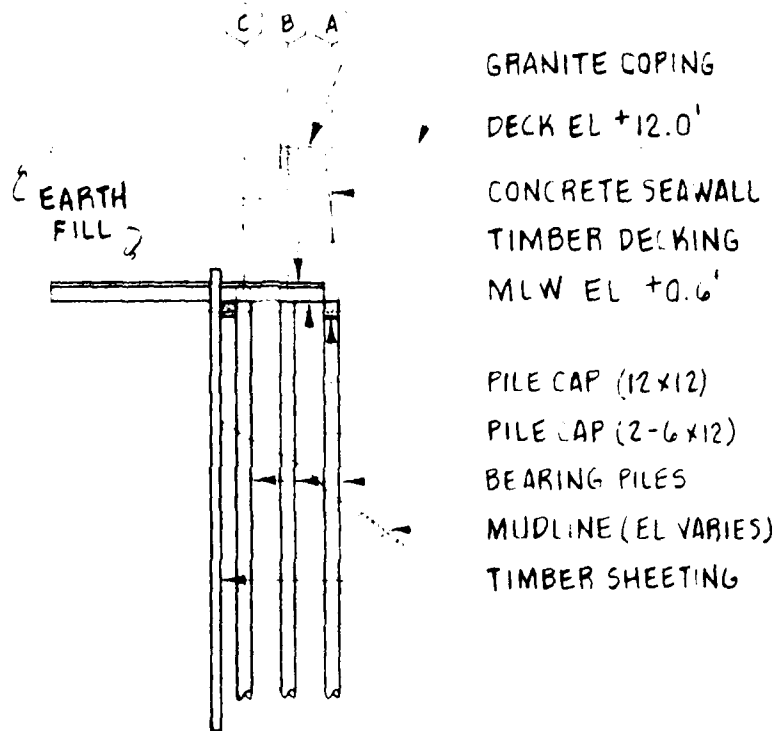
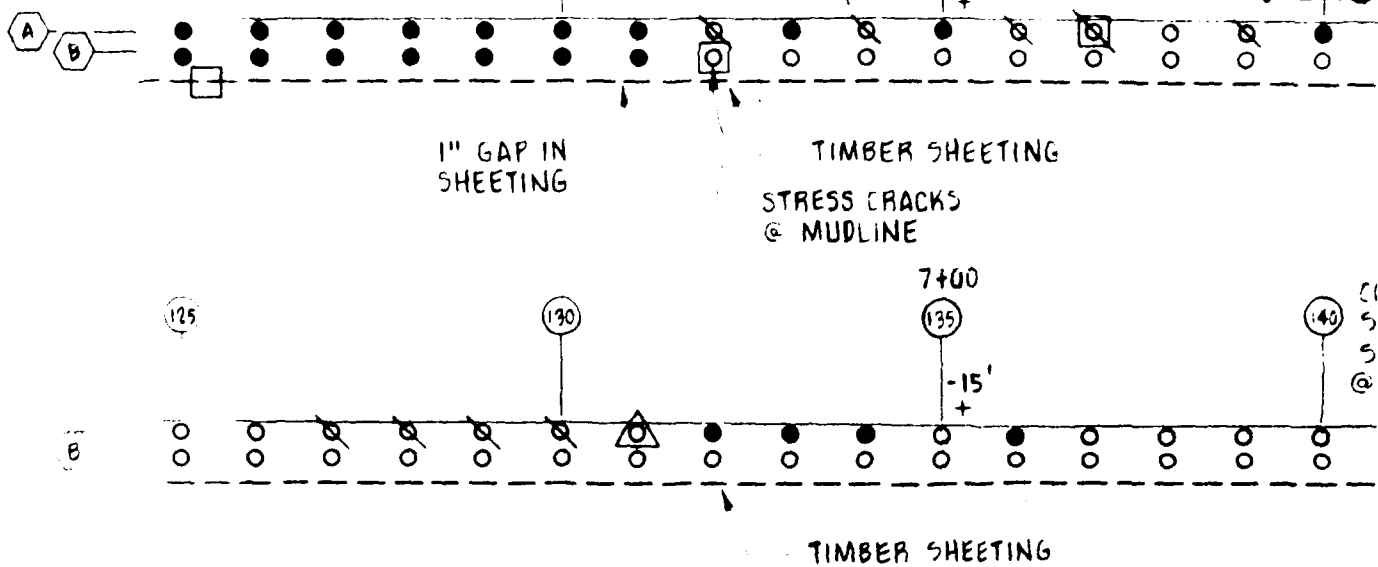
LEGEND

- ⊙ WILD PILE
- ◇ NON-BEARING PILE
- BROKEN PILE
- ↘ DISPLACED-SPLIT PILE
- CORE LOCATION (PILE, CAP, DECK) LEVEL 3 INSPECTION
- 10" — MINIMUM PILE DIAMETER, LEVEL 2 INSPECTION
- 25' SOUNDINGS IN FEET BELOW MLW
- TIMBER BEARING PILE
- ⊖ TIMBER BATTER PILE
- ③ BENT NO. DESIGNATION
- ⬡ PILE DESIGNATION



NOTES:

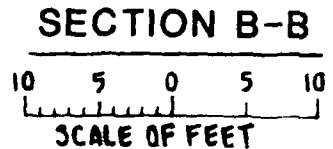
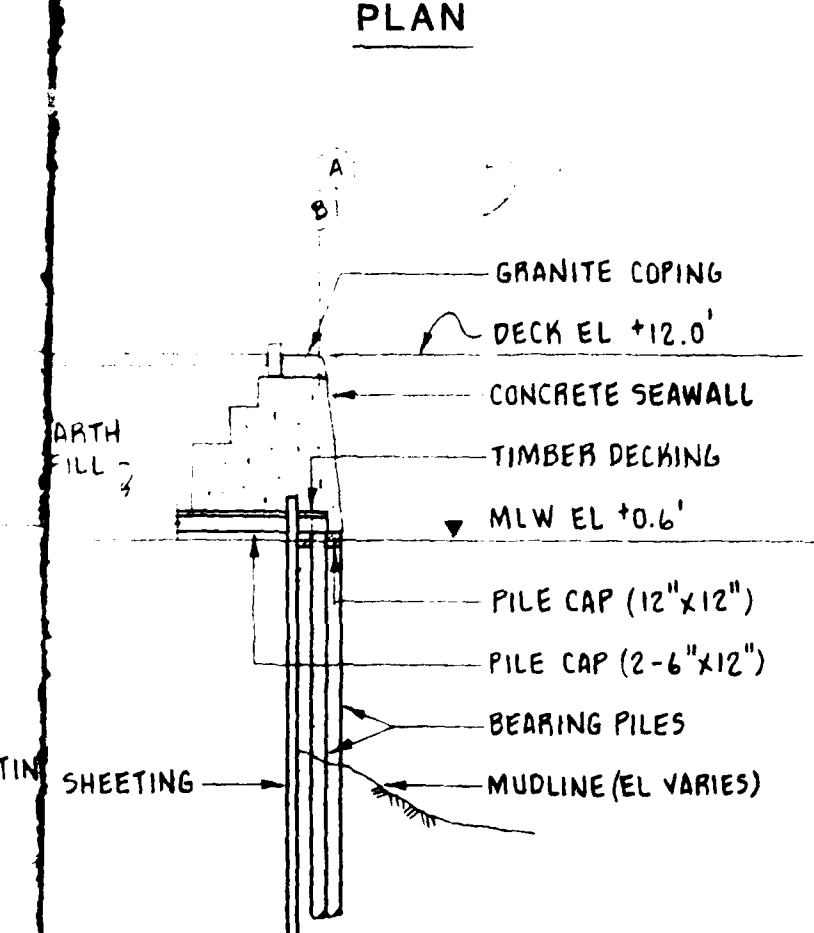
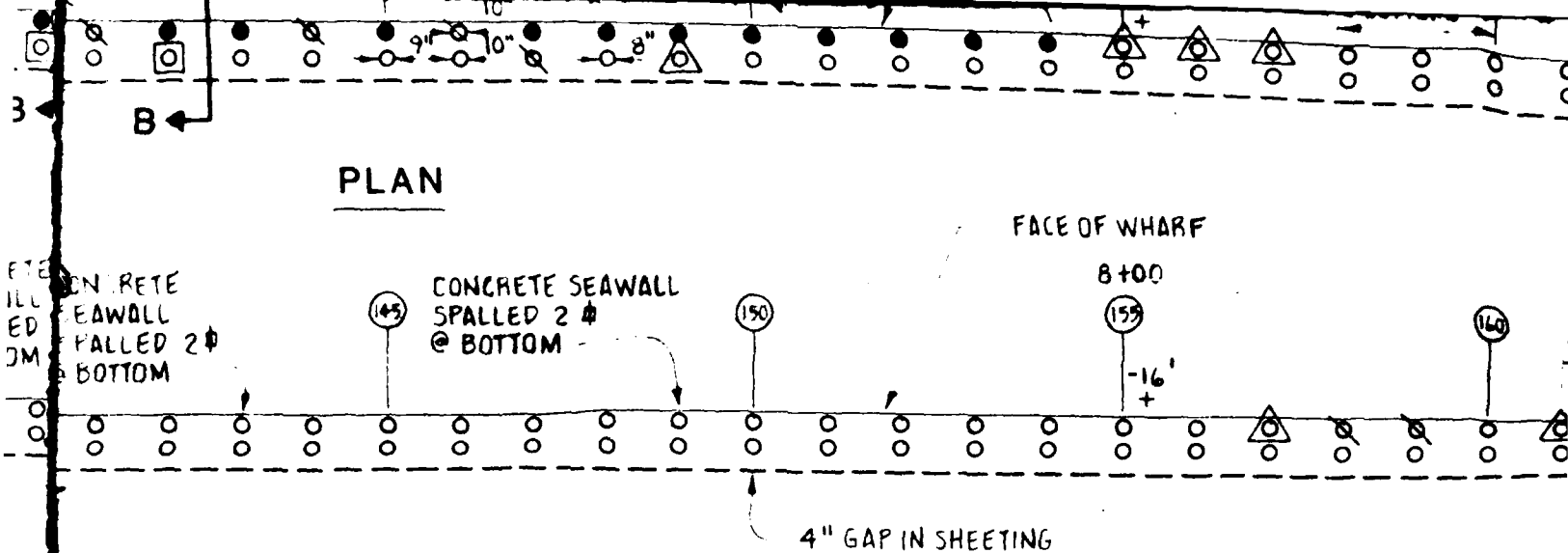
1. LEVEL 1 INSPECTION ON ALL PILES-HIGHER LEVELS OF INSPECTION WHERE NOTED.
2. CORE SAMPLES INDICATE 1"-2" OF SOFTNESS, A TYPICAL CONDITION.
3. REFERENCES: HUDSON ENGINEERS SURVEY - 1976
SHT 15, PW DWG NOS B-1797, C-1511,
C-1512, C-13539, B-1794 &
NAVFAC DWG NO. 1387596.

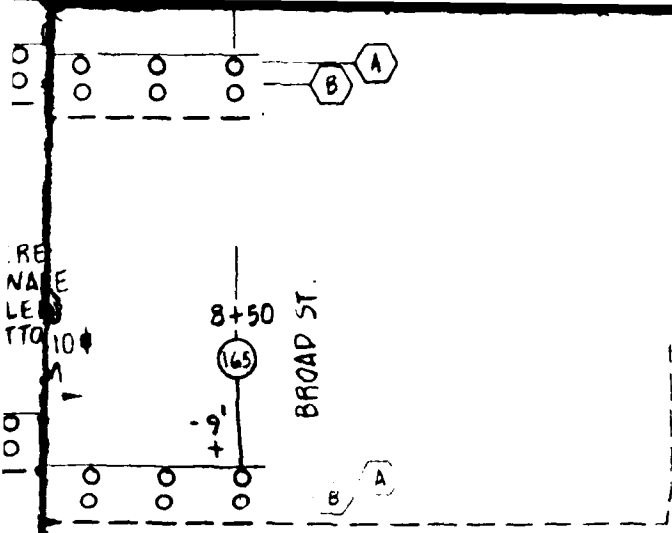


SECTION A-A

5 0 5 10 20

SCALE OF FEET





OF INSPECTION WHERE NOTED.

2. CORE SAMPLES INDICATE 1" - 2" OF SOFTNESS, A TYPICAL CONDITION.
- 3 REFERENCES : HUDSON ENGINEERS SURVEY - 1976
SHT 15, PW DWG NOS B-1797, C-1511, C-1512, C-13539, B-1794 &
NAVFAC DWG NO. 1387596.

3

GRAPHIC SCALE	CHILDS ENGINEERING CORPORATION BOX 333 MEDFIELD, MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C.	
AS SHOWN		PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA PREBLE AVE. WHARF FIG. NO. 87	

4.17.2 OBSERVED INSPECTION CONDITION

Quantities of specific anomalies detected which relate to the structural piles are listed as follows:

- 87 - Broken piles
- 21 - Split and displaced piles
- 1 - Non-bearing pile
- 7 - Wild piles

These anomalies can be located on Figure 87.

Core samples of the structural timber indicate that there is softness to a depth of 2" in some timber piles (see Photo #61 for typical pile-pile cap juncture). Generally, the softness is 1-1/2". The timber pile clamps and decking are in sound condition. The timber sheet pile wall is also in sound condition although minor gaps between sheets were found, along with isolated areas of abrasion (see Photo #62). Softness of up to 2" was detected on the timber sheet piles (see Photo #63).

The concrete seawall is showing signs of deterioration. In various locations there are vertical cracks ranging in width from hairline to 2" wide. Corresponding to locations where there are large numbers of broken perimeter piles, the lower outshore corner of the concrete seawall has either broken or spalled away (see Photos #64 and 65 and Appendix A-26). Associated with this damage to the seawall is deterioration of the longitudinal timber pile cap. Generally the longitudinal pile cap is missing or displaced due to excessive berthing and mooring forces.



PHOTO NO. 61: Preble Ave. Wharf, Bents 52-53,
Pile 8; typical pile-pile cap
juncture. Pile is broken below
the pile cap.

PHOTO NO. 62: Preble Ave. Wharf, Bents 52-53;
illustrates abrasion of timber
sheet pile wall. Knife has
penetrated wall approx. 2".





PHOTO NO. 63: Preble Ave., Bent 52, El.-5';
illustrates timber sheet pile
softness. Penetration of knife
is approx. 2".

PHOTO NO. 64: Preble Ave. Wharf, Bents 87-88;
illustrates damage to lower out-
shore corner of concrete seawall.

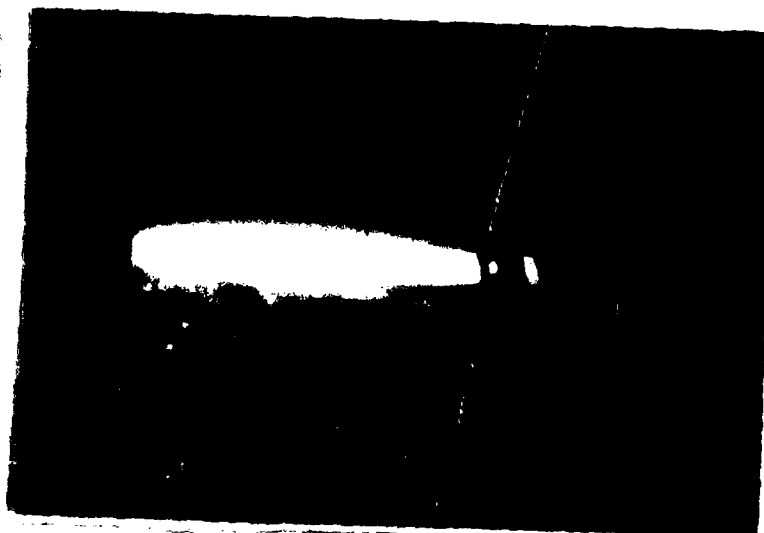




PHOTO NO. 65: Preble Ave., Bent 87; photo illustrates pile clamp end which is exposed due to the loss of lower portion of the concrete seawall.

Fasteners used to connect the pile clamps to the piles appear to be slightly corroded with approximately 10-15% loss of steel, (see Photo #66). The fender system is generally non-functional throughout most of the length of the wharf.



PHOTO NO. 66: Preble Ave. Wharf, Bent 48,
Pile A; bolt fastening pile to
sheet pile wall. Note pile is
shaved to accommodate bolt.
Pile diameter is approx. 10".

4.17.3 STRUCTURAL ASSESSMENT

The broken or split piles found in various concentrations along the wharf are apparently caused by excessive forces transmitted by fendering camels. The forces transmitted by a camel typically originate from the berthing and mooring forces of ships. The loss of concrete from the lower portion of the seawall is also attributed to these excessive forces. Slight settlement and cracking of the seawall in some locations are related to the absence of support due to the broken piles.

There has been no change in the cross-sectional area of the timber piles since they were driven. However, softness of the timber piles found throughout the wharf indicates that an adjustment to the minimum pile diameter is necessary in the calculation of the pile's column capacity (see Appendix A-11). Assuming a reduced minimum diameter of 7", the column capacity is 19 tons, which is greater than the 15 tons driven capacity, therefore the driven capacity is the limiting factor. The pile foundation is capable of supporting its designed loading based on an assumed maximum area of 16 sq. ft. supported by one bearing pile. Calculations indicate that where there has been no mechanical damage, the live-load capacity need not be reduced due to timber softness. Although there is some loss of steel on the fasteners there does not appear to be a major loss of cross-sectional area.

4.17.4 RECOMMENDATIONS

The 87 broken piles should be replaced. New creosoted timber piles should be driven adjacent to the broken perimeter piles and sprung in under the longitudinal pile cap. The interior piles which are broken should be long-posted. The estimated cost per pile is \$1,000, the total estimated cost is \$87,000. Where the longitudinal pile cap is damaged or missing it should be replaced. Where the concrete seawall is broken away, full bearing between the pile cap and the seawall should be attained. There are approximately 210 lineal feet of pile cap that should be replaced. At an estimated cost of \$5/bd.ft. in place, the total estimated cost is \$12,600. The 21 split and displaced piles, 1 non-bearing and 7 wild piles should be repositioned and refastened to the pile cap or clamp. At an estimated cost of \$400/pile, the total estimated cost is \$11,600. Conceptual repair details can be found in the Appendix (A-20 to A-28).

If the wharf is continued to be used as a mooring for inactive ships and berthing/mooring forces are expected, a fender system should be installed and the use of camels should be discontinued.

Live-loading in deck areas directly associated with damaged (broken, split and wild) piles should be restricted to 25% of the current recommended live-load capacity until those piles are repaired. Following the implementation of the recommended repairs, live-loading can be maintained at current levels (200 psf). The estimated future life of the Preble Ave. Wharf is in

AD-A168 466

UNDERWATER FACILITIES INSPECTIONS AND ASSESSMENTS AT

27

PHILADELPHIA NAVAL AIRSHIP ENGINEERING CORP

MEDFORD MA OCT 83 CMES/NAUTAC-FPO-1-83(48)-3

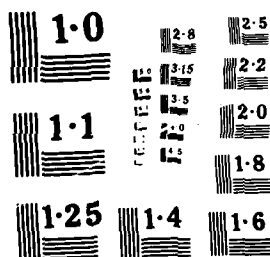
UNCLASSIFIED

NO2477-81-C-0440

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DATE
7-86
(11)



excess of 10 years. The entire wharf should be re-inspected after repairs and every 2 years thereafter. This will enable Shipyard personnel to monitor any change in conditions with particular attention being paid to the timber softness. This report should be used as a baseline for future inspections.

4.18 BROAD STREET WHARF













4.18.1 DESCRIPTION

Broad Street Wharf is located on the eastern perimeter of the Reserve Basin and is bordered by the Preble Avenue Wharf to the south and Wharf L to the north, (see Figures 4 [Vol. I] and 88). The timber pile-supported, earth-filled, low deck, relieving platform structure with gravity concrete seawall was constructed circa 1899. The structure measures approximately 735' in length. Timber sheet piling is located about 30' inshore of the seawall. Approximately 1,440 piles, including batter piles are arranged in bents with 4-foot spacing, (see Figure 88). The design pile capacity is assumed to be 15 tons for vertical piles. The deck elevation is +12.0'. The designated live-load capacity at the time of our inspection was 100 psf. During our inspection no vessels were being moored on the wharf.

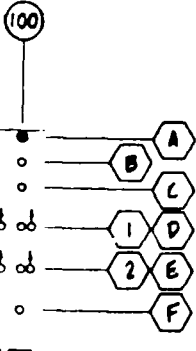
The westernmost lane of Broad Street runs over the relieving platform with that lane extending to the "F" pile row. From the "F" pile row to the "A" pile row the top deck of the structure is used as a sidewalk for pedestrian traffic only.

Reference 2 (see Appendix A-29)

LEGEND

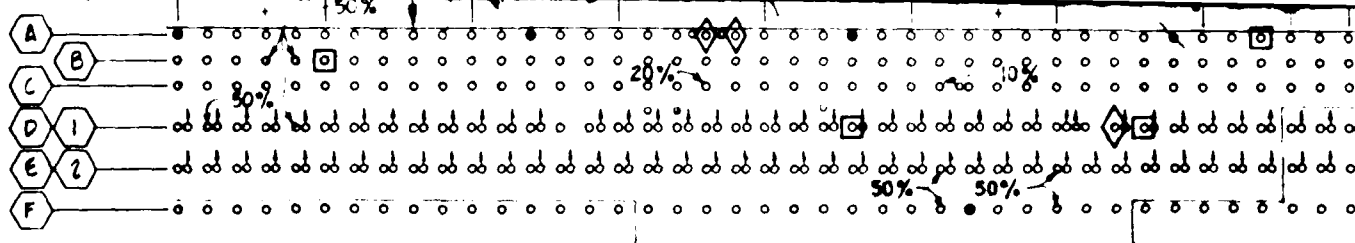
-  WILD PILE
-  NON-BEARING PILE
-  BROKEN PILE
-  DISPLACED-SPLIT PILE
-  CORE LOCATION (PILE, CAP, DECK) LEVEL 9 INSPECTION
-  10" MINIMUM PILE DIAMETER, LEVEL 2 INSPECTION
-  -25' SOUNDINGS IN FEET BELOW MLW
-  50% OF PILE BEARING ON PILE CAP
-  TIMBER BEARING PILE
-  TIMBER BATTER PILE
-  BENT NO. DESIGNATION
-  PILE DESIGNATION

SPALLING APPROX
14' ON SEAWALL



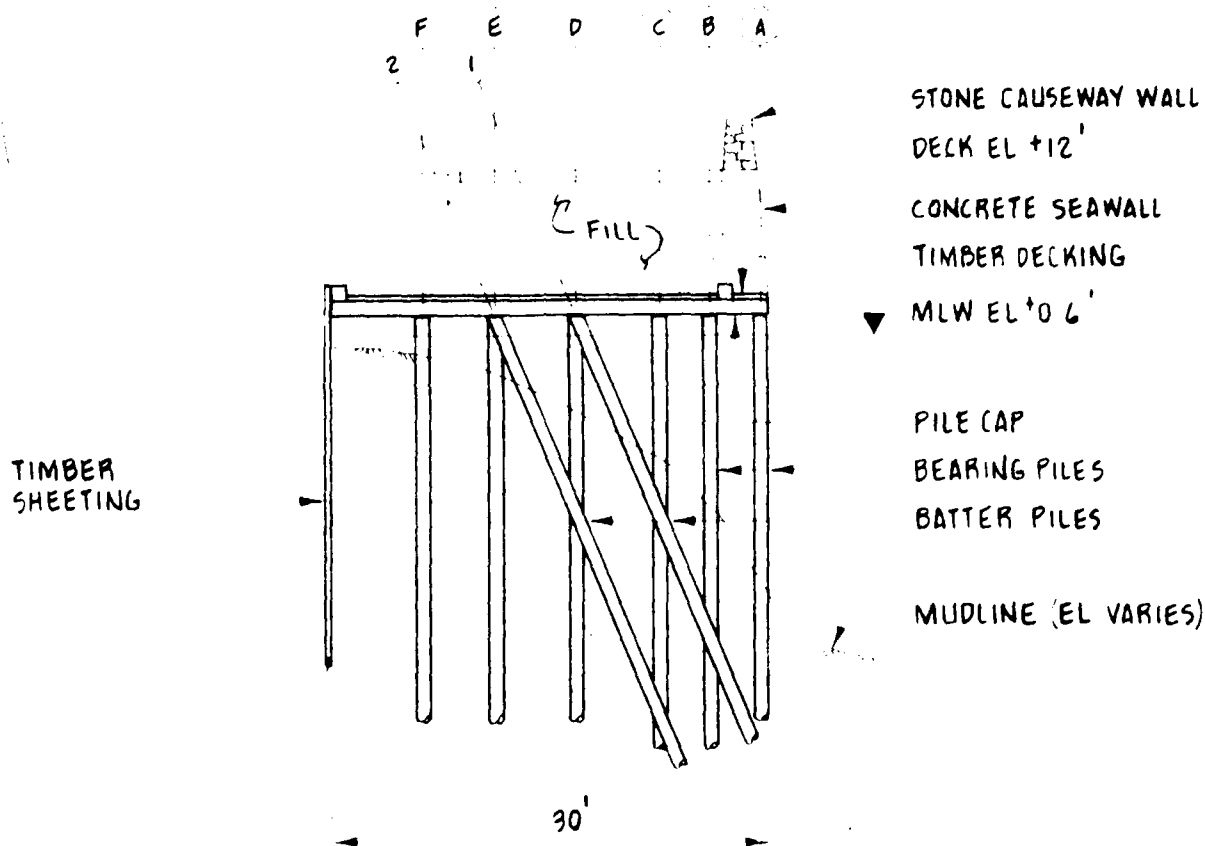
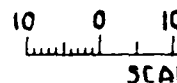
NOTES:

1. LEVEL 1 INSPECTION ON ALL PILES-HIGHER LEVELS OF INSPECTION WHERE NOTED.
2. CORE SAMPLES INDICATE $1\frac{1}{2}$ " OF SOFTNESS, A TYPICAL CONDITION.
3. REFERENCE: HUDSON ENGINEERS SURVEY-1976
SHT , PW DWG NOS. C-1508,
C-1509, C-1511, C-1512, C-1513,
B-1788, C-13539.

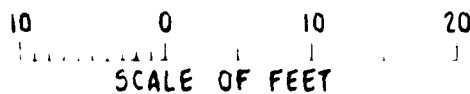


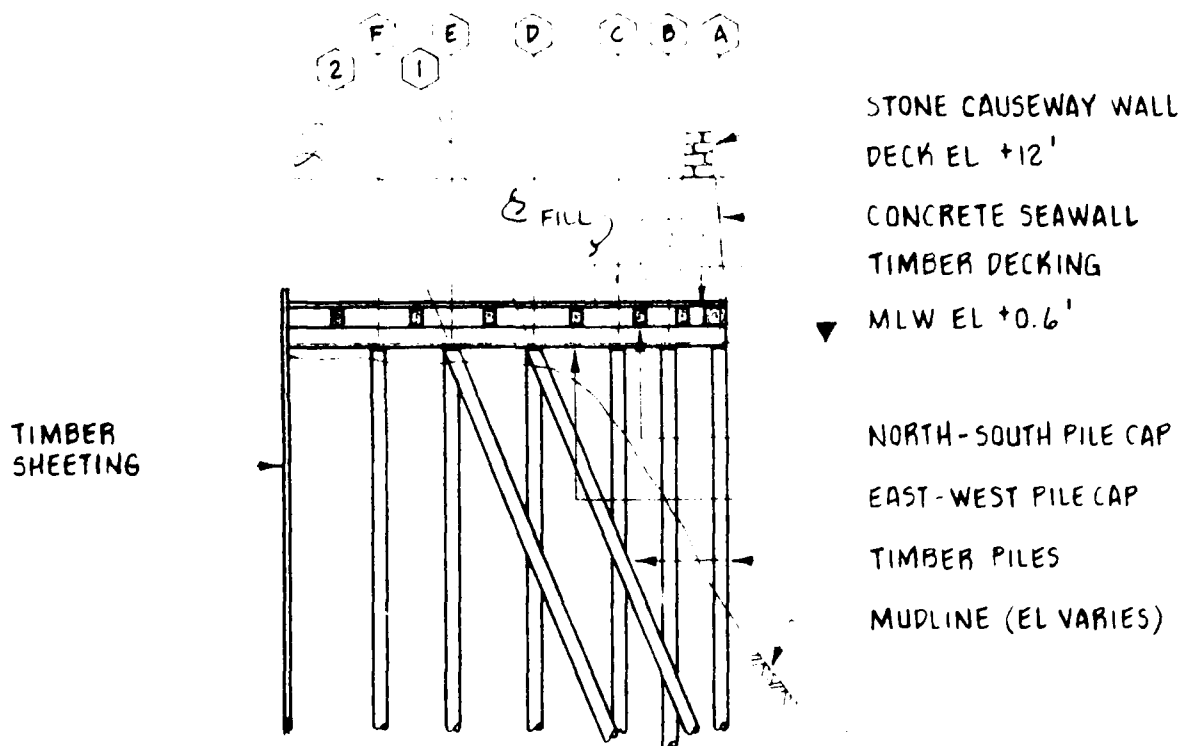
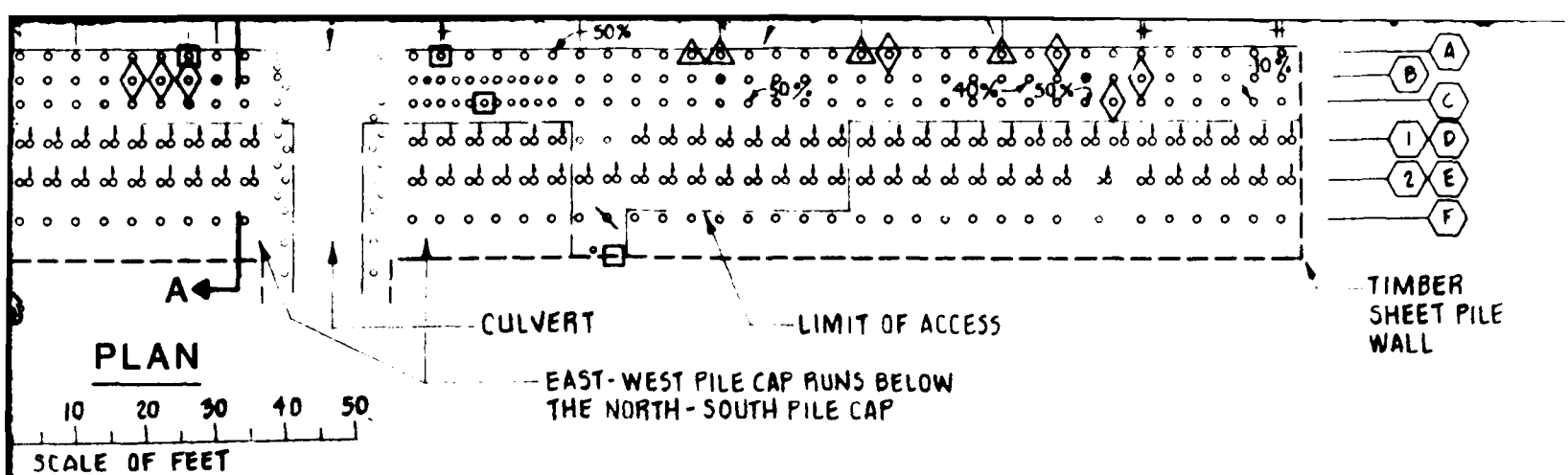
TIMBER SHEETING

PILE CAP DEFLECTED DOWN
6" @ SHEET PILE WALL



TYPICAL CROSS-SECTION





1. TYPE & INSPECTION ON REEFED HIGH LEVEL
OF INSPECTION WHERE NOTED.

2. CORE SAMPLES INDICATE $1\frac{1}{2}$ " OF SOFTNESS,
A TYPICAL CONDITION.

3. REFERENCE: HUDSON ENGINEERS SURVEY-1976
SHT , PW DWG NOS. C-1508,
C-1509, C-1511, C-1512, C-1519,
B-1788, C-15539.

GRAPHIC SCALE

AS SHOWN

CHILDS ENGINEERING
CORPORATION
BOX 333
MEDFIELD, MA

CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C.

PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA

BROAD ST. WHARF

FIG. NO.

88

4.18.2 OBSERVED INSPECTION CONDITION

Quantities of specific anomalies detected which relate to the structural piles are listed as follows:

- 13 - Broken piles
- 2 - Split and displaced piles
- 13 - Non-bearing piles
- 4 - Wild piles
- 24 - Partially-bearing piles

These anomalies can be located on Figure 88, (see Photo #67).

Core samples and general probing of the timber reveal there is a maximum of 3" of soft timber detected, with 1-1/2" of softness being typical. The timber piles are effected by the softness more consistently than the pile caps and deck planks. The corners of the cut timber are soft while the center of the cut timber is sound. Pile diameters range from 11" to 14".

Pile spacing varies from as little as 3' to as much as 6'. There are some perimeter piles which are not plumb and battered to the outshore direction. From Bents 115 to 132 the pile cap between the F pile and the timber sheet pile wall is deflected downward, with a maximum of 6" deflection at Bents 128 through 132, (see Photos #68 and #69).

A cursory inspection was made of the culvert beginning at Bent 147. The structure is a concrete arch tunnel with utility boxes intersecting perpendicularly through the top of the arch. Apparently, the intersecting utility boxes were constructed after the culvert was constructed. Presently there is a timber formwork



PHOTO NO. 67: Broad St. Wharf, Bent 134, Pile A;
illustrates split perimeter pile
with drift pin exposed. Approx.
25% of the top 2' of the pile is
missing.

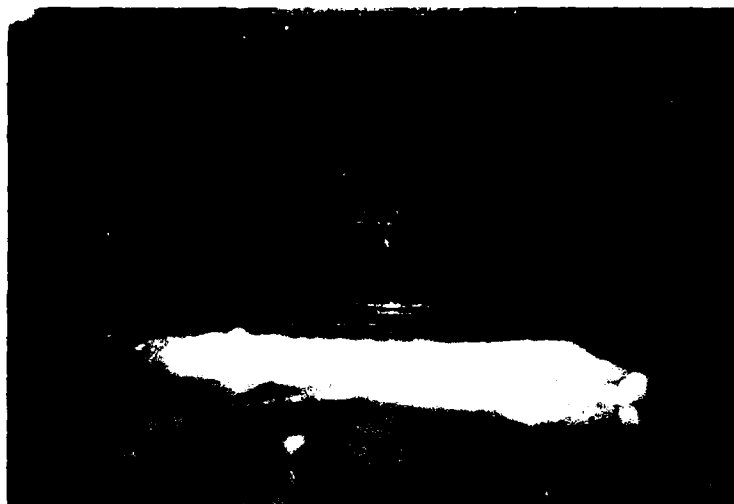
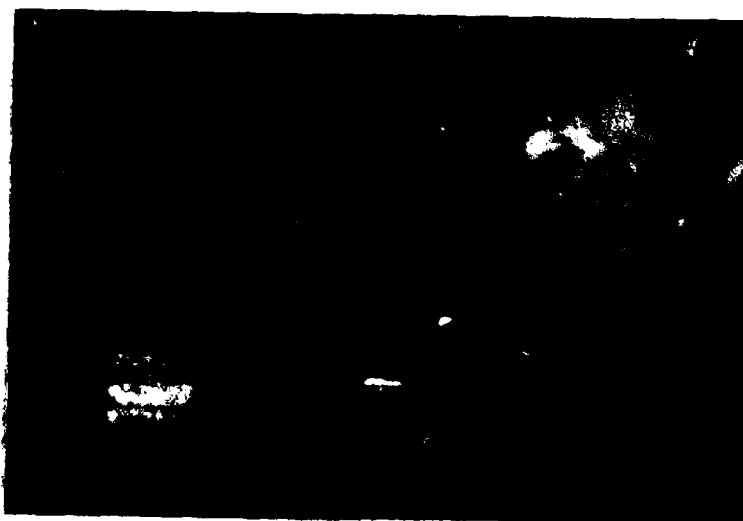


PHOTO NO. 68: Broad St. Wharf, Bents 131-132;
illustrates typical construction
of wharf. Note deflection of
pile caps, debris in water.

PHOTO NO. 69: Broad St. Wharf, Bent 131;
illustrates typical construction
of wharf. Note condition of
steel bolt, nut and washer, and
debris in water.



which is visible, with evidence that concrete has been poured to form a box-like cut through the top of the arch. The formwork is hung from the top of the arch. There is no visible deterioration of the formwork. Access to the interior of the utilities was not gained. A hairline crack in the concrete was detected at the apex of the arch running the length of the culvert to at least the extent of the inspection, approximately 250'.

4.18.3 STRUCTURAL ASSESSMENT

Split and displaced piles and broken piles are apparently caused by excessive berthing and mooring forces transmitted through fendering camels. There has been no change in the cross-sectional area of the timber piles since they were driven. However, the observation of soft timber throughout the wharf prompts the reduction of the area of timber used in the analysis of the structure. The analysis is similar to the typical analysis of the relieving platform previously performed in the Appendix, (A-9 to A-11) except for the increased loading imposed on the piles and pile caps due to 6' pile spacing. Calculations pertinent to the change in spacing are located in the Appendix (A-16 to A-18). As a result of the calculations, certain assumptions which were made have to be questioned. It is shown that in assuming a saturated earth fill weight of 125#/cu.ft., the horizontal shear stress exceeds the assumed allowable 120 psi (100 psf live-load not included). The actual horizontal shear stress developed in the timber is found to be approximately 160 psi using an earth fill saturated weight of 125#/cu.ft. The result is timber working beyond accepted design limits. An apparent result of this is the notable deflection found from Bents 115 through 132 of the pile cap between the F pile and the timber sheet pile wall. Due to the limited access available to the divers, the full extent of the deflected pile caps could not be determined. Realistically, a live-load limit cannot be determined without further investigation (not within our scope of work) of the structure. The true satu-

rated weight of the earth fill should be determined and the allowable horizontal shear stress of the timber should be determined, also the support of the pile cap at or beyond the sheet pile wall should be verified. Apparently the ultimate stresses within the timber have been reached, as observed in the deflected pile caps. The timber deck and timber piles are capable of supporting the previously designated 100 psf live-load, however, it is questionable as to whether the pile caps can support that same load with the present pile spacing.

The hairline crack occurring at the top of the culvert is not a significant structural anomaly at this point in time.

4.18.4 RECOMMENDATIONS

The overall condition of the structural timber of the Broad Street Wharf is not good. Softness of the timber was found throughout the structure. This weakening of the timber along with the original design of 6' spacing between some piles has resulted in the apparent overstressing of the pile cap. Due to these characteristics of the structure and the absence of an investigation of the necessary detail (beyond the scope of this project) live-loading should be restricted to 50 psf on the top deck of the structure which includes the sidewalk and westernmost lane of Broad Street. In view of the function of this facility as a portion of the main access to the naval shipyard, long range plans for reconditioning or construction of a new bulkhead should be prepared with the concept of increasing the live-load capacity of the structure. A tied-back, steel sheet pile bulkhead similar to that constructed along Rowan Avenue would significantly increase the live-load capacity of the structure with minimal disruption to vehicular traffic. Alternate traffic patterns can be found on NAVFAC Drawing No. 2044115.

Short term repairs would include the repair of 13 broken piles at an estimated cost of \$1000/pile, the total estimated cost is \$13,000. The 2 split and displaced, 13 non-bearing, 24 partially bearing and 4 wild piles should be refastened or posted as needed at an estimated cost of \$400/pile, the total estimated cost is \$17,200.

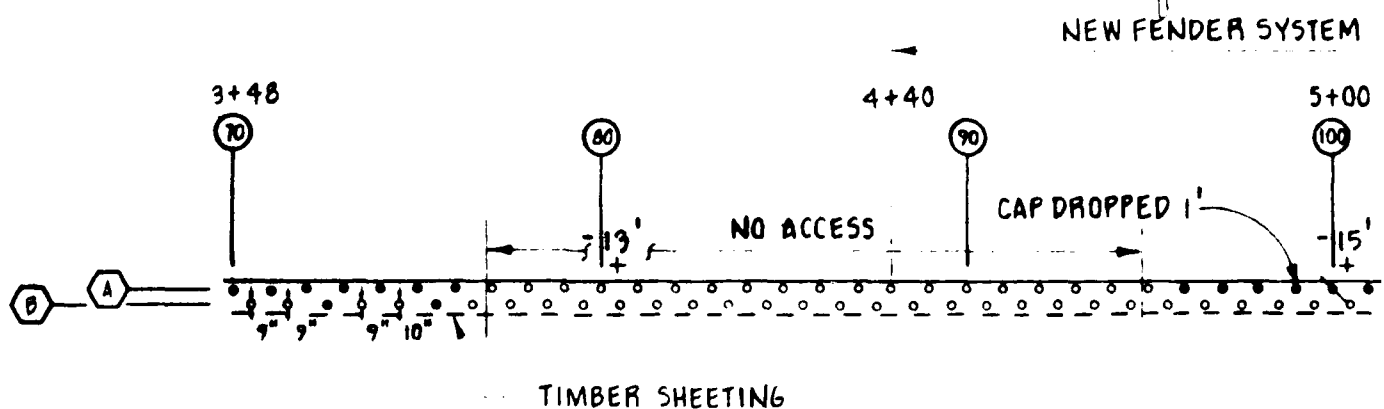
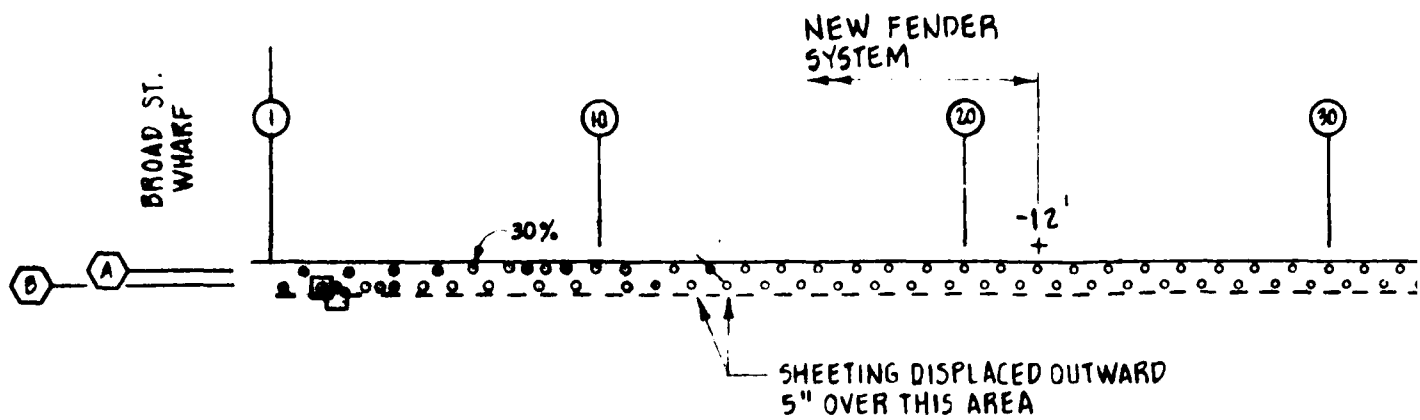
The entire wharf should be monitored on a 6-month basis to determine any change in conditions. Particular attention should be paid to the pile cap deflection between the timber sheet pile wall and the "F" pile row. The estimated future life of Broad St. Wharf is less than 10 years. This report should be used as a baseline for future inspections.

4.19 WHARF L

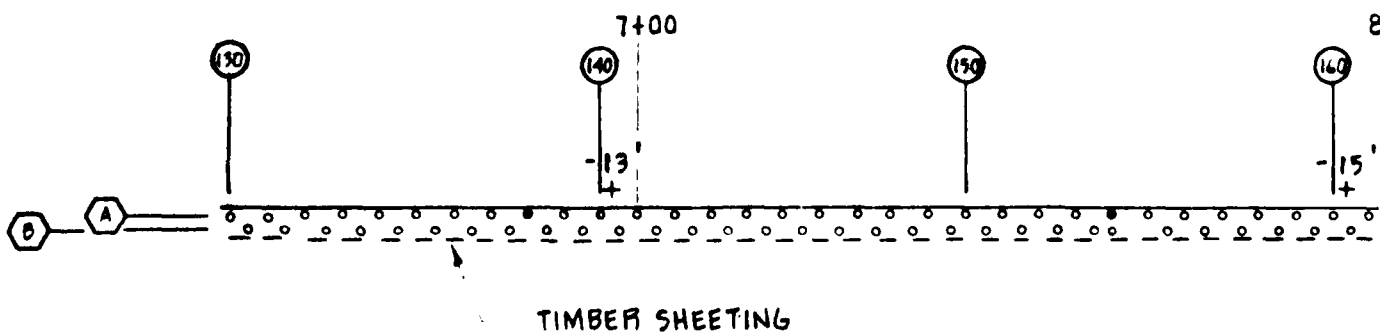
4.19.1 DESCRIPTION

Wharf L is located on the northern perimeter of the reserve basin and is bordered by the Broad Street Wharf to the east and Wharf N to the west (see Figures 4 [Vol. I] and 89). The timber pile-supported, earth-filled, low deck, relieving platform structure was constructed circa 1900. The structure measures approximately 930' in length. Timber sheet piling is located approximately 5 feet inshore of the seawall and extends from the underside of the timber decking to the basin bottom. There are approximately 400 accessible piles arranged in the following manner; perimeter piles spaced 5 feet apart support a perimeter pile cap that runs east to west. Bents running north to south are spaced 5 feet apart but are staggered with respect to the perimeter piles. Only one pile in each bent is accessible. The remaining piles in each bent lie to the north of the timber sheet pile wall. The design pile capacity is assumed to be 15 tons. The deck elevation is +12.0'. The designated live-load capacity at the time of our inspection is 200 psf. During our inspection, Wharf L was being used as a permanent mooring for three inactive heavy cruisers. A typical section of Wharf L can be found on Figure 89.

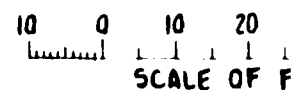
Reference 2 (see Appendix A-29)



PLAN

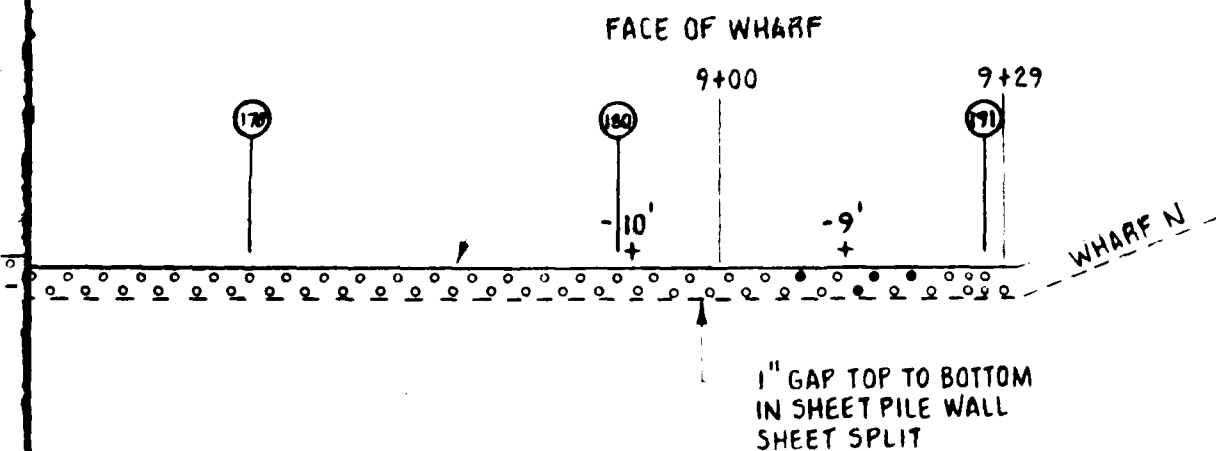
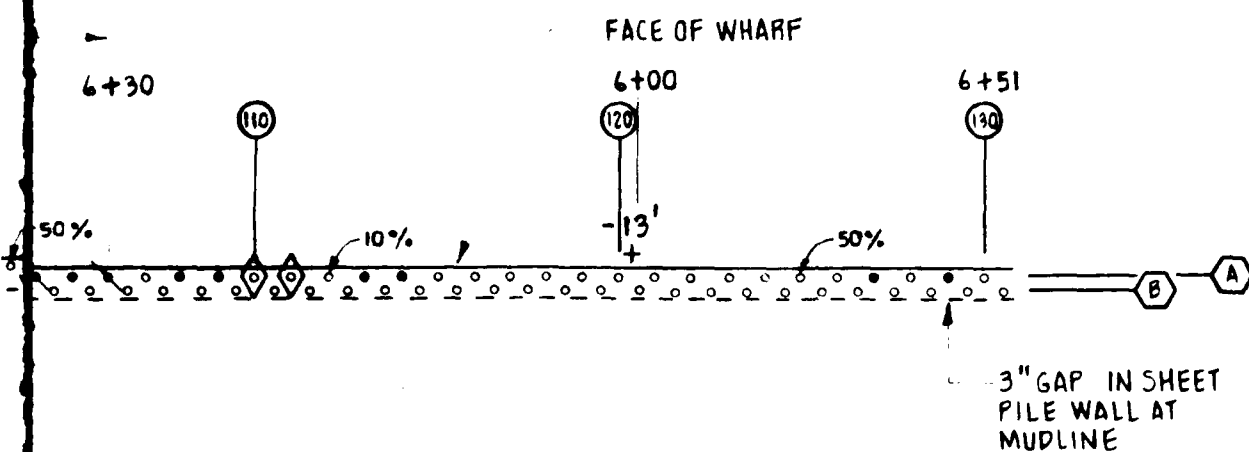
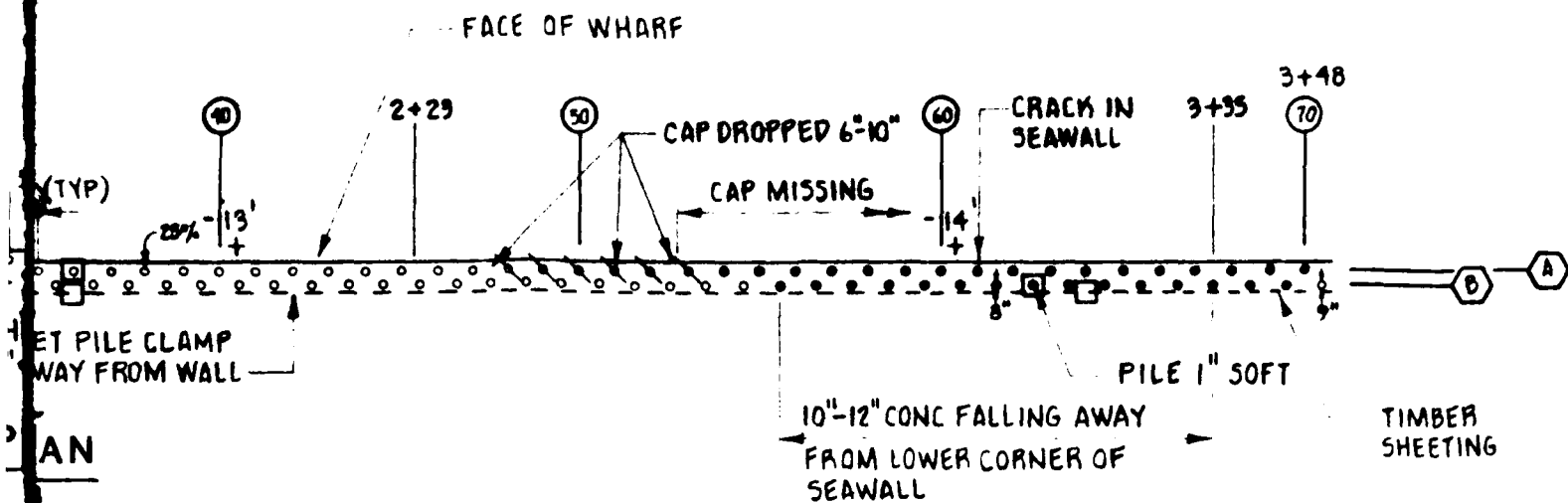


PLAN




GRANITE COPING

DECK EL +12.0'

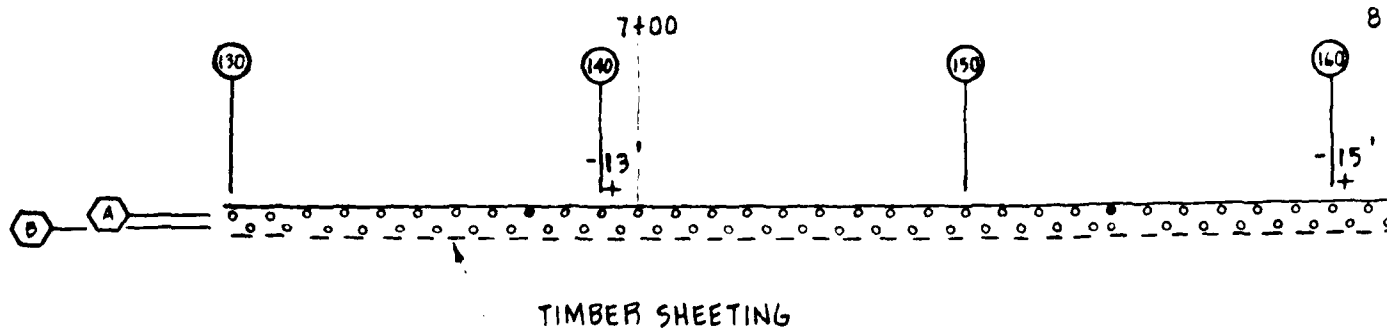


LEGEND

- 
- ◊ NON-BEARING PILE
 - BROKEN PILE
 - ↘ DISPLACED-SPLIT PILE
 - CORE LOCATION (PILE, CAP, DECK) LEVEL 3 INSPECTION
 - 10" — ○ — MINIMUM PILE DIAMETER, LEVEL 2 INSPECTION
 - 25' SOUNDINGS IN FEET BELOW MLW
 - 50% 8 50% OF PILE BEARING ON PILE CAP
 - TIMBER BEARING PILE
 - ! TIMBER BATTER PILE
 - ③ BENT NO. DESIGNATION
 - ⬡ PILE DESIGNATION

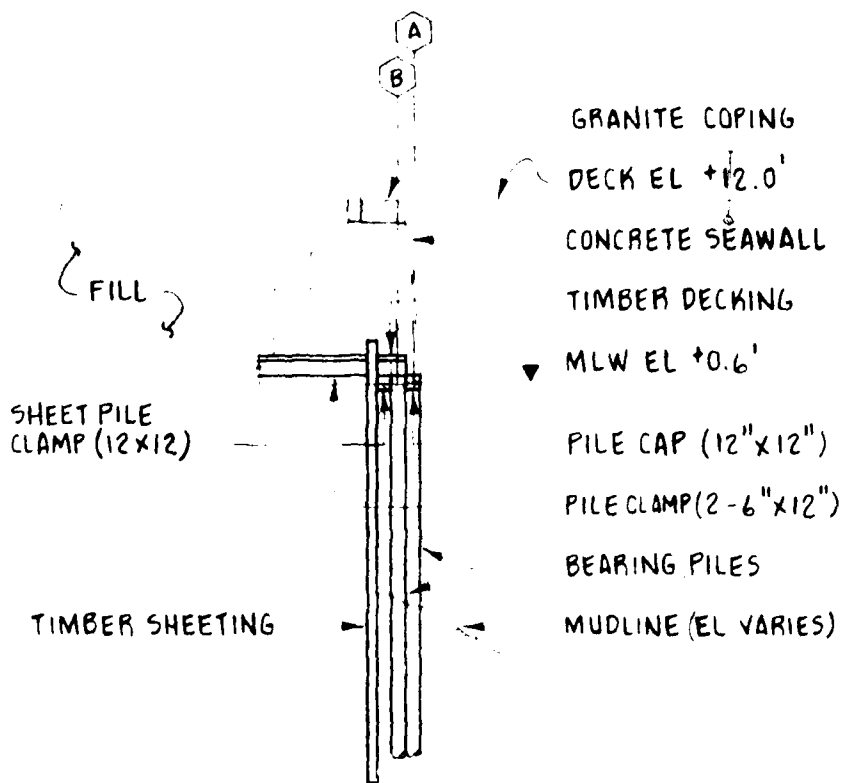
NOTES:

1. LEVEL 1 INSPECTION ON ALL PILES-HIGHER LEVELS OF INSPECTION WHERE NOTED.
2. CORE SAMPLES INDICATE $\frac{1}{2}$ " TO 1" OF SOFTNESS A TYPICAL CONDITION.
3. BETWEEN BENTS 77 & 93 ASSUME ALL PILES ARE MISSING.
4. REFERENCE: HUDSON ENGINEERS SURVEY-1976
SHT 17, PW DWG NOS. C-1507, C-1513,
C-1514, B-1794.



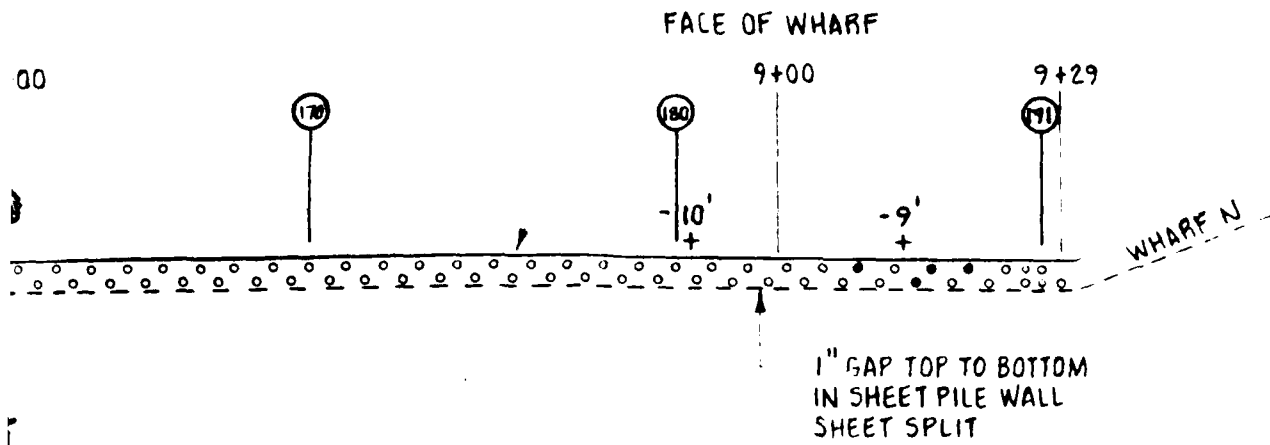
PLAN

10 0 10 20
SCALE OF FEET



TYPICAL CROSS-SECTION

10 5 0 5 10
SCALE OF FEET



30 40 50
ET

5

NOTES:

1. LEVEL 1 INSPECTION ON ALL PILES-HIGHER LEVELS OF INSPECTION WHERE NOTED.
2. CORE SAMPLES INDICATE $\frac{1}{2}$ " TO 1" OF SOFTNESS A TYPICAL CONDITION.
3. BETWEEN BENTS 77 & 93 ASSUME ALL PILES ARE MISSING.
4. REFERENCE: HUDSON ENGINEERS SURVEY-1976
SHT 17, PW DWG NOS. C-1507, C-1513,
C-1514, B-1794.

2

GRAPHIC SCALE	CHILDS ENGINEERING CORPORATION BOX 333 MEDFIELD, MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C.	
6 AS NOTED		PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA WHARF L	FIG. NO. 89

4.19.2 OBSERVED INSPECTION CONDITION

Specific anomalies detected which relate to the structural piles are listed as follows:

- 99 - Broken piles
- 2 - Non-bearing piles
- 11 - Split and displaced piles
- 5 - Partially-bearing piles

These anomalies can be located on Figure 89.

Visual inspection of core samples of timber piles, caps, decking and sheeting indicate 1/2" to 1-1/2" of softness in the timber, (see Photo #70). In particular, pile caps show softness at the cap corners. Minimum pile diameters measured ranged from 9" to 10". Evidence of past marine borer activity was observed in one isolated area; however, marine borers were inactive at the time of our inspection.

Extensive damage to the wharf was observed between Stations 2+35 and 5+70. As Figure 89 denotes, the diver/engineers were unable to gain access to the piles between Stations 3+84 and 4+70 due to a ship being moored adjacent to that area. Most piles in this area were either broken or split, and the perimeter pile cap was either missing or displaced downward as much as 12".

The concrete seawall is showing some signs of deterioration. In various locations there are vertical cracks ranging in width from hairline to 6" wide. These cracks correspond to locations where there are large numbers of broken perimeter piles and the lower outshore corner of the concrete seawall has either broken or spalled away (see Figure 89 and Photo #71).

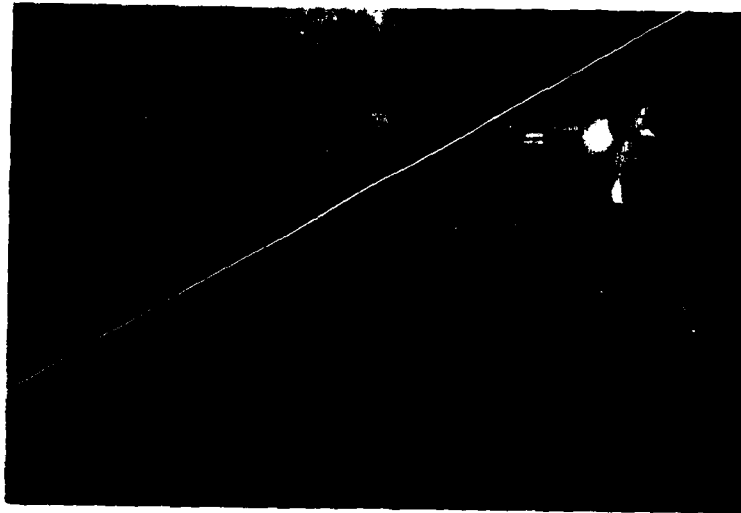
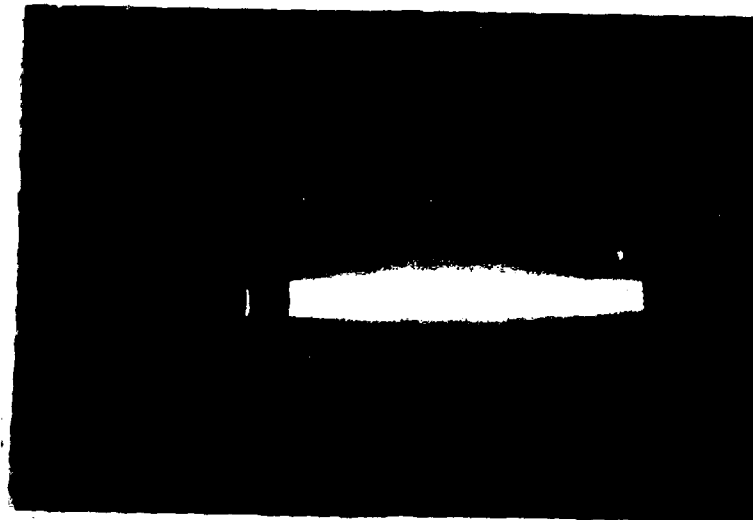


PHOTO NO. 70: Wharf L, Bent 60, Pile A;
illustrates softness in timber
pile. Knife has penetrated approx.
1-1/2".

PHOTO NO. 71: Wharf L, Bent 59; typical concrete
spalling along perimeter pile cap.



Four 1" to 5" gaps were observed in the timber sheet pile wall along Wharf L. The gaps typically occur at the mudline and were probably formed during construction. No significant loss of fill was observed at any of the gaps. Core samples of the timber sheet piles indicate that there is softness to a depth of 1".

The fender system is in poor condition throughout most of the length of the wharf, with two exceptions: a new fender system has been installed between Stations 0+00 and 1+07, and between Stations 4+40 and 6+30.

Fasteners used to connect the pile clamps to the piles appear to be slightly corroded with approximately 10-15% loss of steel.

4.19.3 STRUCTURAL ASSESSMENT

Most of the specific anomalies listed in the previous section are a result of local berthing and fendering forces. These lateral forces are responsible for the observed damage to piles, the perimeter pile cap, and the lower outshore corner of the concrete seawall.

There has been no change in the cross-sectional area of the timber piles since they were driven. However, softness of the timber piles found throughout the wharf indicates that a reduction of the minimum pile diameter is necessary in the calculation of the piles' column capacity. Assuming a reduced minimum diameter of 7", the column capacity is 17 tons, (see Appendix A-19) which is greater than the 15 tons driven capacity, therefore the driven capacity is the limiting factor. The pile foundation is therefore capable of supporting its designed loading.

No extensive loss of fill from gaps in the timber sheet pile wall was observed. No sinkholes or depressions in the pavement adjacent to the gaps were observed. We conclude that the gaps in the sheet pile wall do not pose a serious threat to the integrity of the wharf.

4.19.4 RECOMMENDATIONS

The 99 broken piles should be replaced. New creosoted timber piles should be driven adjacent to the broken perimeter piles and sprung in under the longitudinal pile cap. The interior piles which are broken should be long-posted. The estimated cost per pile is \$1,000, the total estimated cost is \$99,000. The perimeter pile cap should be replaced in areas where it is damaged or missing. Where the lower outshore corner of the concrete seawall is broken away, full bearing should be attained on the pile cap. There are approximately 265 linear feet of pile cap that should be replaced. At an estimated cost of \$5/bf in place, the total estimated cost is \$15,900. The 18 non-bearing, partially bearing, wild, or split and displaced piles should be repositioned and refastened to the pile cap or clamp. At an estimated cost of \$400/pile, the total estimated cost is \$7,200. Conceptual repair details can be found in the Appendix (A-20 to A-28). If the wharf is to be used as a mooring for inactive ships and berthing/mooring forces are expected, a fender system should be installed.

Live-loading in deck areas directly associated with damaged (broken, split and wild) piles should be restricted to 25% of the current recommended live-load capacity until those piles are repaired. Following implementation of the recommended repairs, live-loading can be maintained at current levels (200 psf). The estimated life of Wharf L is in excess of 10 years. The entire wharf should be re-inspected after repairs and every two years thereafter with particular attention being paid to the timber

softness. This will enable Shipyard personnel to monitor any change in conditions. This report should be used as a baseline for future inspections.

4.20 WHARF N

4.20.1 DESCRIPTION

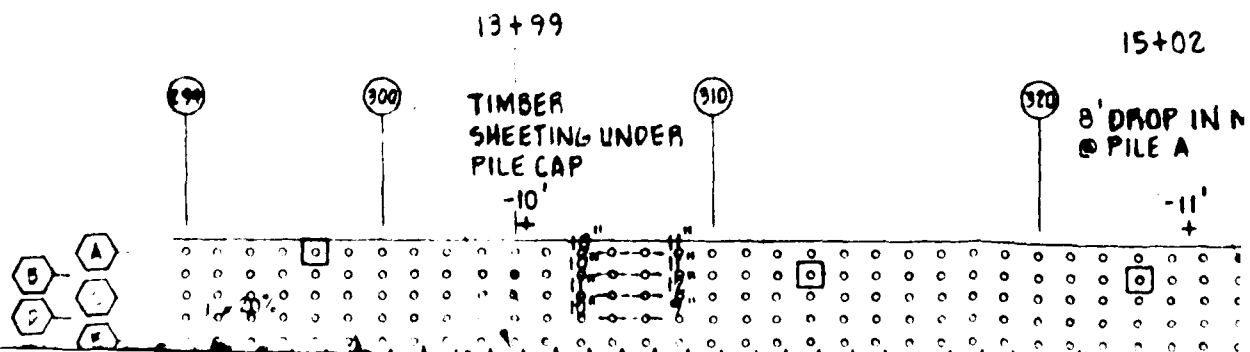
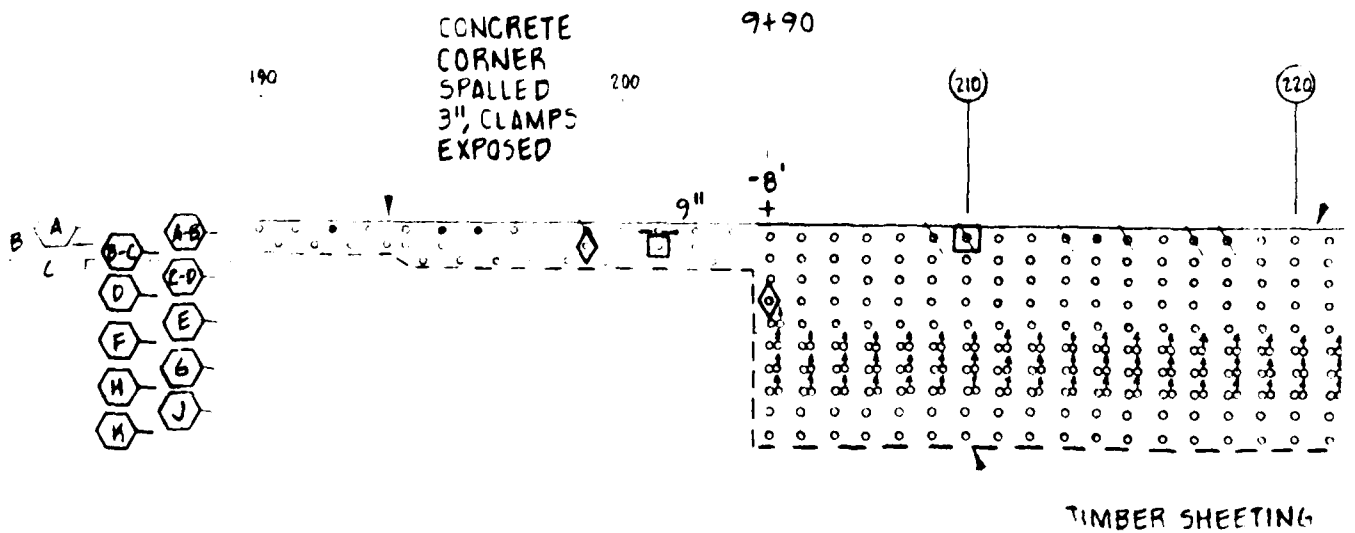
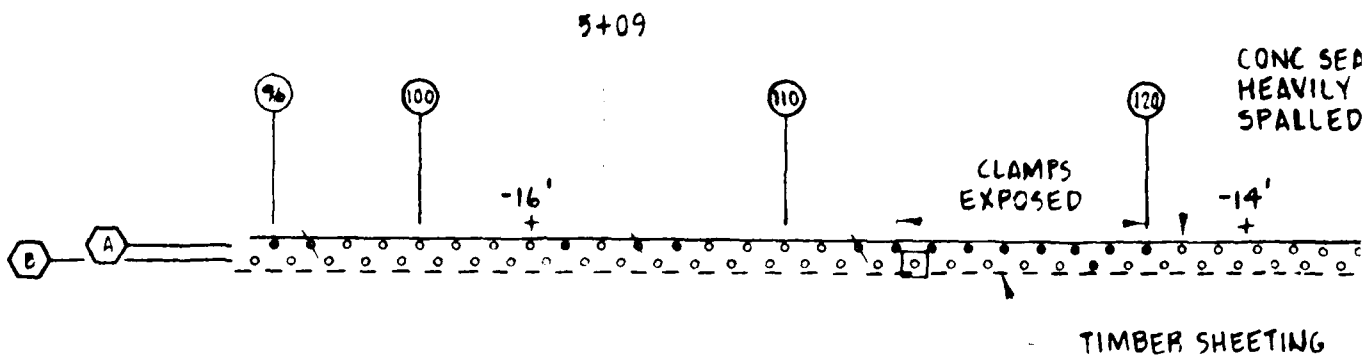
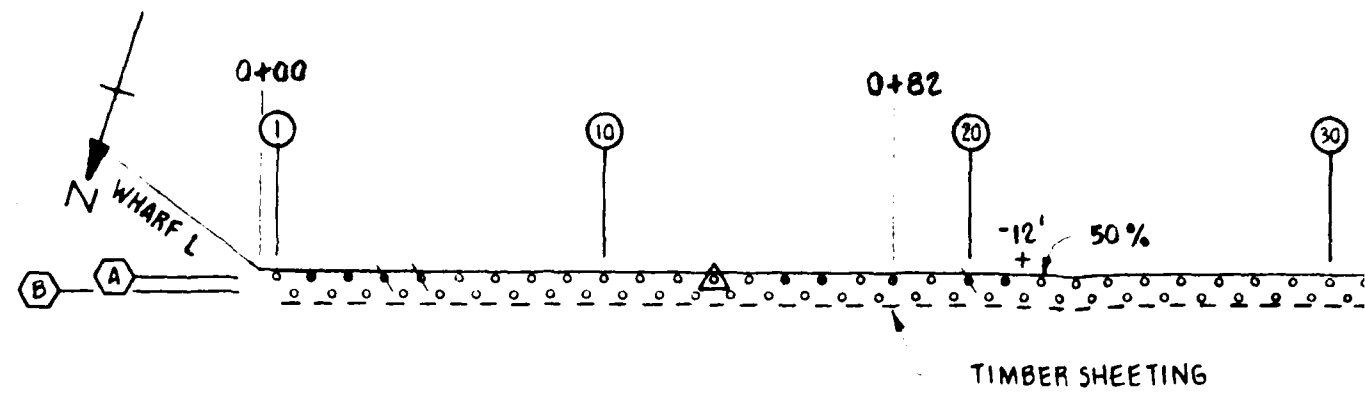
Wharf N is located on the northern perimeter of the Reserve Basin and is bordered by Wharf L to the east, (see Figures 4 [Vol. I] 90 and 91). From Station 0+00 to Station 21+88, the wharf is a timber pile-supported, earth filled, low deck, relieving platform structure; from Station 21+88 to Station 33+48 the wharf is composed of steel sheet pile cells or diaphragms. The wharf from Station 0+00 to Station 9+75 was constructed circa 1903. Station 14+00 to Station 19+50 was constructed circa 1941; the remaining portion of the timber pile-supported structure was constructed circa 1943. The date of construction of the steel sheet pile cells is unknown. The entire wharf measures approximately 3,348' in length.

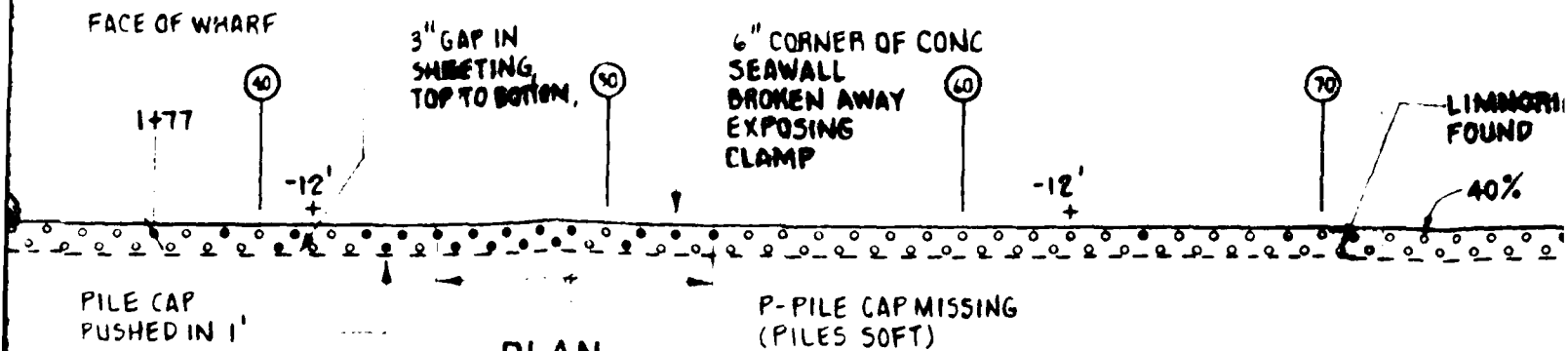
Between Station 0+00 and Station 9+90, timber sheet piling is located approximately 5 feet inshore of the seawall and extends from the underside of the timber decking to the basin bottom. Perimeter piles spaced 5 feet apart support a perimeter pile cap that runs east to west. Bents running north to south are spaced 5 feet apart but are staggered with respect to the perimeter piles. Only one pile in each bent is accessible. The remaining piles in each bent lie to the north of the timber sheet pile wall.

Between Station 9+90 and Station 19+50, timber sheet piling is located approximately 30 feet inshore of the seawall. Bent spacing is approximately 5 feet. Between Station 19+50 and Station 21+60,

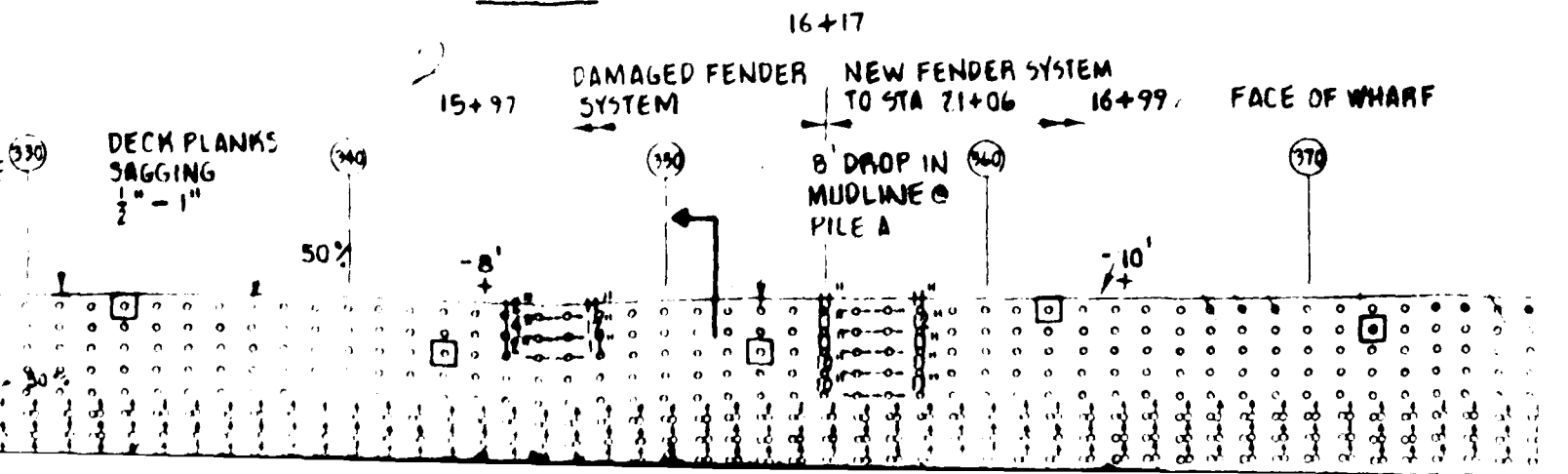
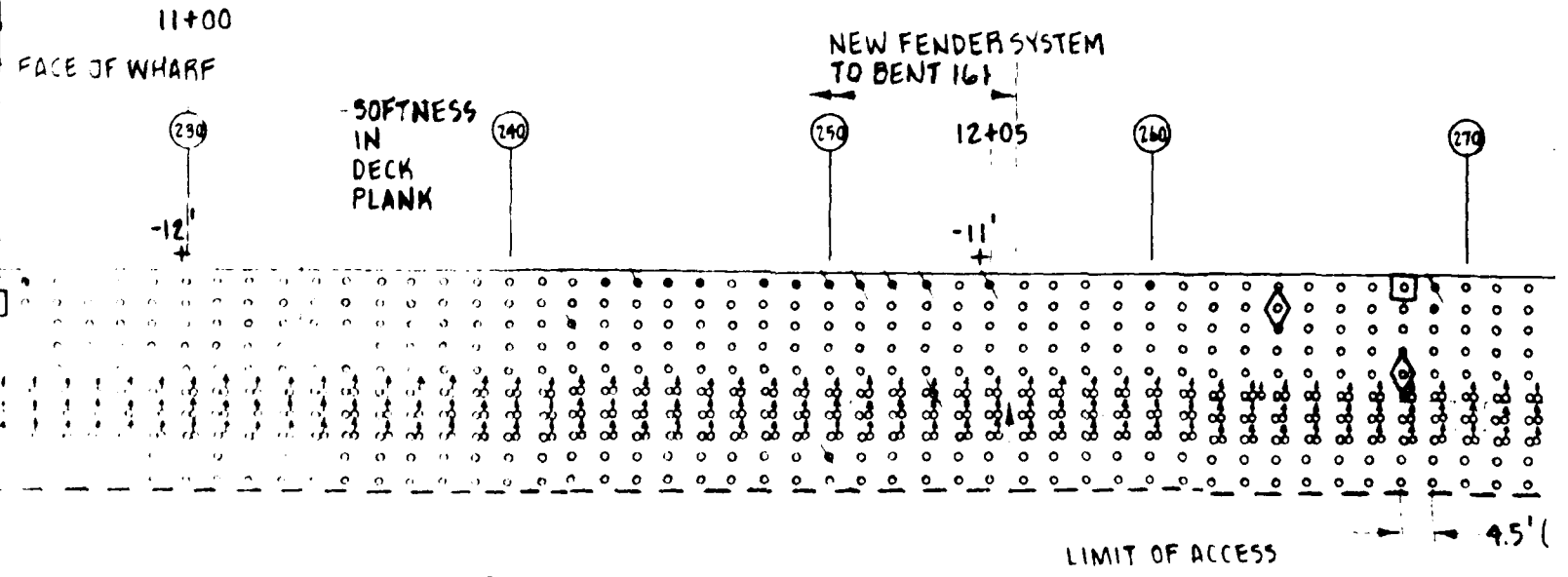
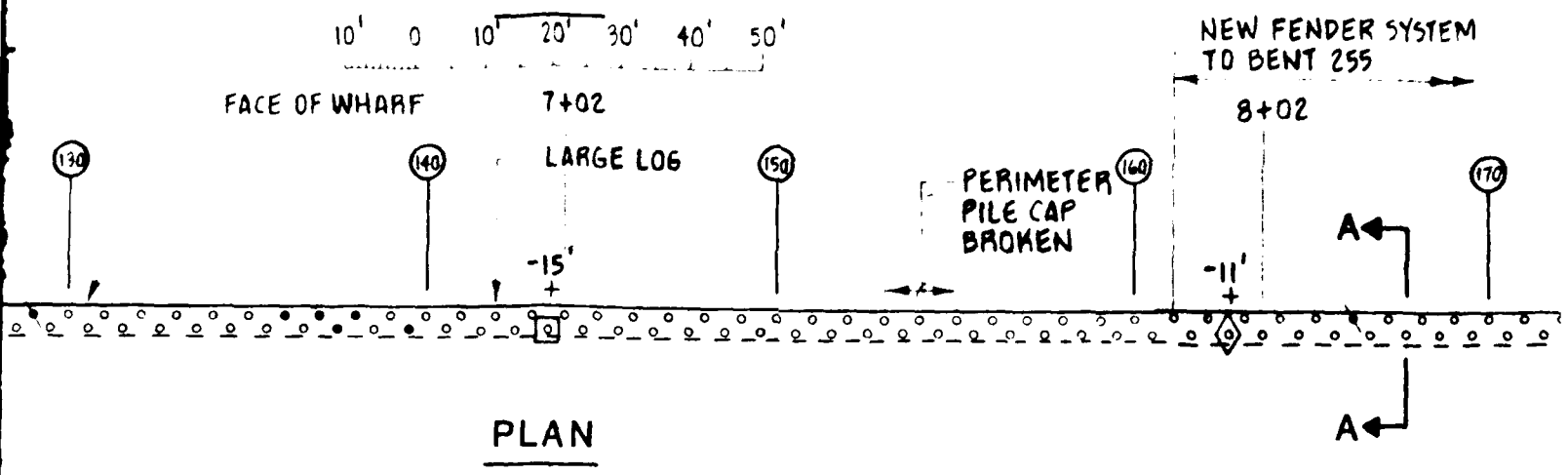
timber sheet piling is located approximately 20 feet inshore of the seawall. Bent spacing is approximately 5 feet. A total of approximately 3,646 timber piles, including batter piles comprise the pile-supported portion of the wharf. The design pile capacity is assumed to be 15 tons for plumb piles and 12 tons for batter piles. The deck elevation along the timber pile-supported portion of the wharf varies between +11.5' and +12.0'; the deck elevation along the steel cell portion of the wharf is +13.0'. The designated live-load capacity at the time of our inspection is 200 psf. During our inspection, Wharf N was being used as a permanent mooring for various inactive vessels.

Reference 2 (see Appendix A-29)





PLAN



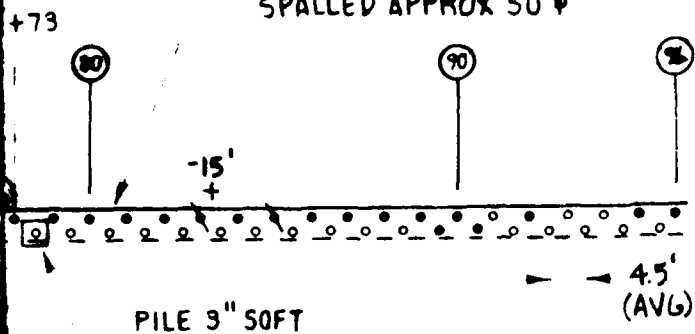
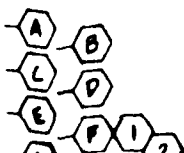
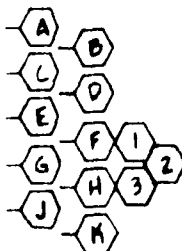
EXPANSION JOINT ON SEAWALL
SPALLED APPROX 50'

LEGEND

- △ WILD PILE
- ◇ NON-BEARING PILE
- BROKEN PILE
- ⋈ DISPLACED-SPLIT PILE
- CORE LOCATION (PILE, CAP, DECK) LEVEL 3 INSPECTION
- 10" MINIMUM PILE DIAMETER, LEVEL 2 INSPECTION
- 75' SOUNDINGS IN FEET BELOW MLW
- 50% 50% OF PILE BEARING ON PILE CAP
- TIMBER BEARING PILE
- ! TIMBER BATTER PILE
- ③ BENT NO. DESIGNATION
- ⬡ PILE DESIGNATION

NOTES:

1. LEVEL 1 INSPECTION ON ALL PILES-HIGHER LEVELS OF INSPECTION WHERE NOTED.
2. CORE SAMPLES INDICATE 1" OF SOFTNESS, A TYPICAL CONDITION.
3. THE EXPOSED FASTENERS FROM STA 0+00 TO STA 9+66 ARE HEAVILY CORRODED WITH UP TO 50% LOSS OF CROSS-SECTIONAL AREA.
4. REFERENCE: HUDSON ENGINEERS REPORT-1976
SHT 18, P.W. DWG NOS. B-1754,
C-1507, C-1513, C-1513, C-1559.



PILE 3" SOFT

CONCRETE
CORNER
SPALLED
2" CLAMPS
EXPOSED

9+11

-11'

4.5' (AVG)

12+99

DECKING
SOFT

-11'

G)

1/4" GAP BETWEEN DECK
PLANKS, SLIGHT SAG IN
DECK PLANKS DETECTED

2" GAP BETWEEN
DECK PLANKS

17+54

MUDLINE
DROPS 7' @
PILE C

-9'

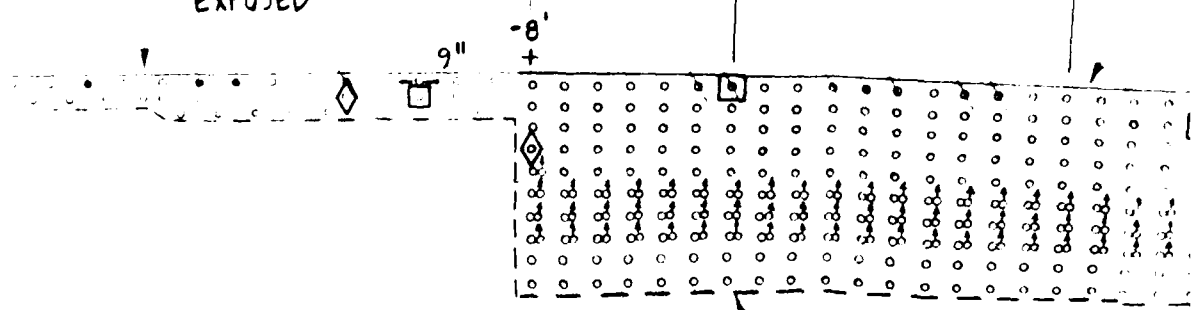
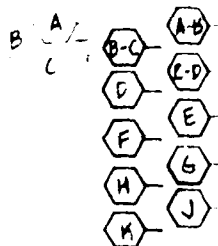
190

CORNER
SPALLED
3" CLAMPS
EXPOSED

200

(210)

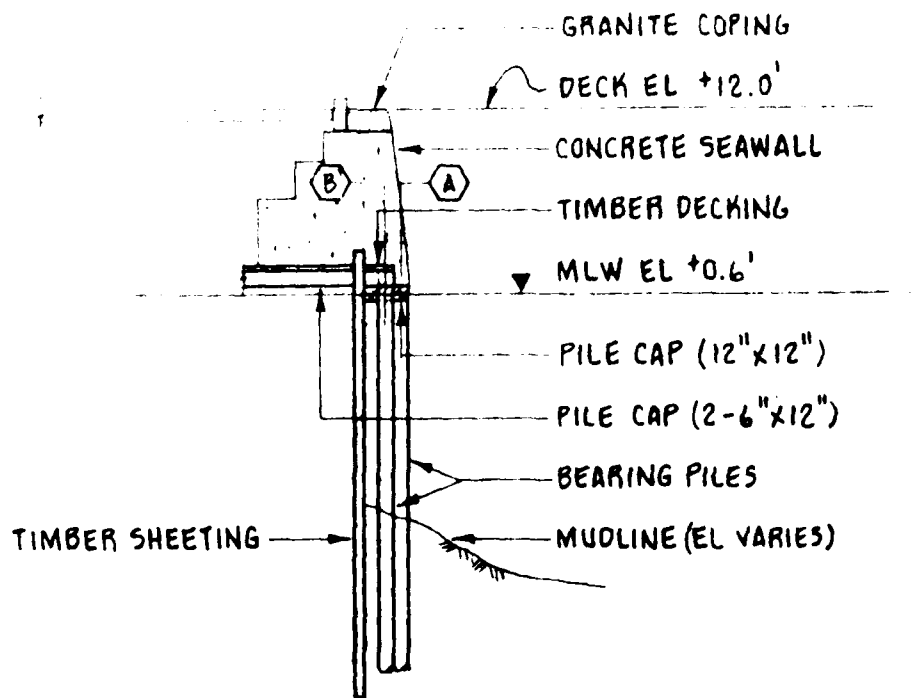
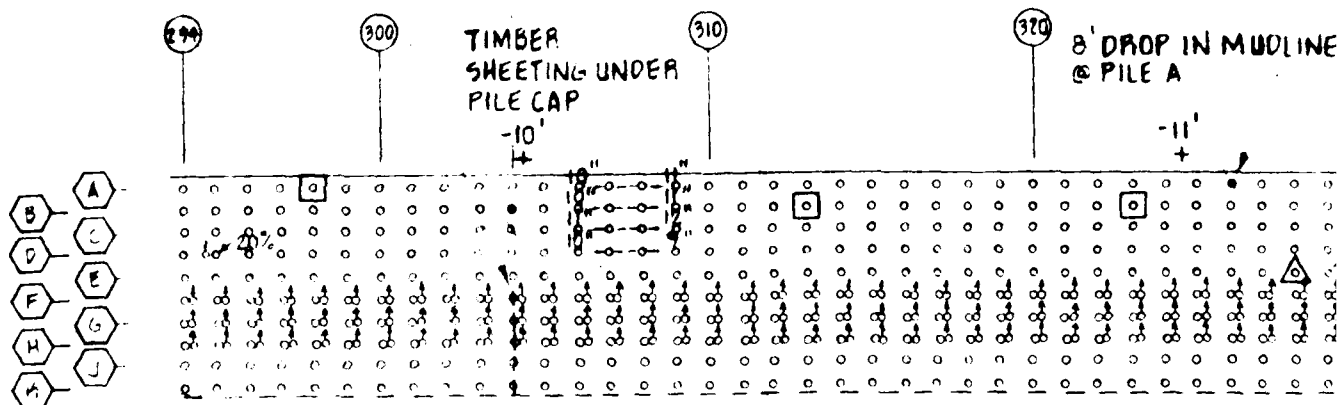
(220)



TIMBER SHEETING

13+99

15+02

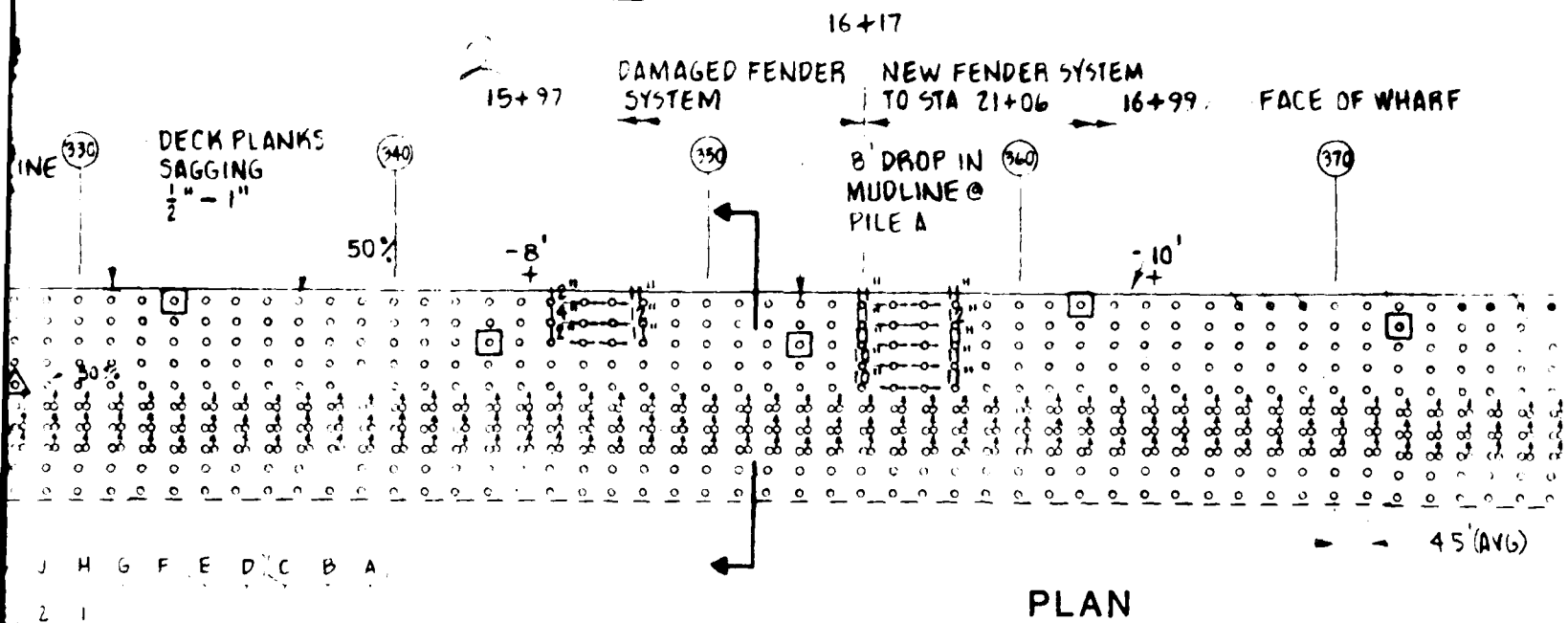
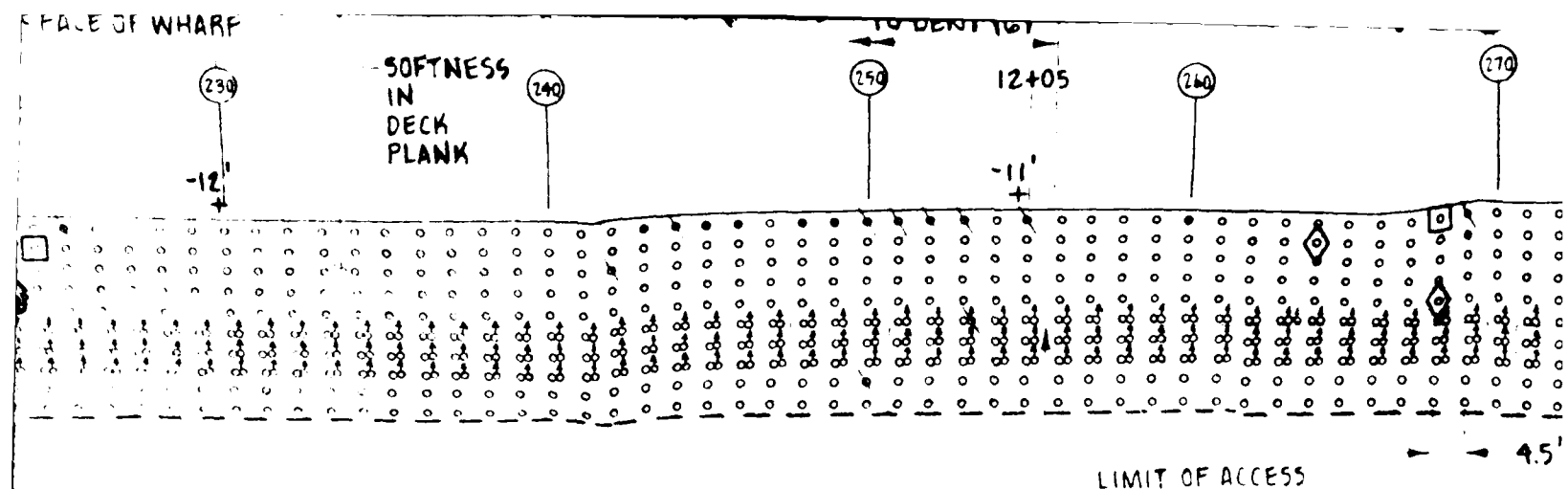


TIMBER SHEETING

SECTION A-A

10 5 0 5 10
SCALE OF FEET

FACE OF WHARF



KING
T

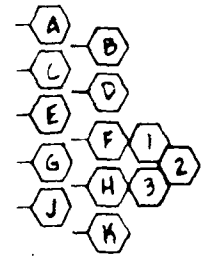
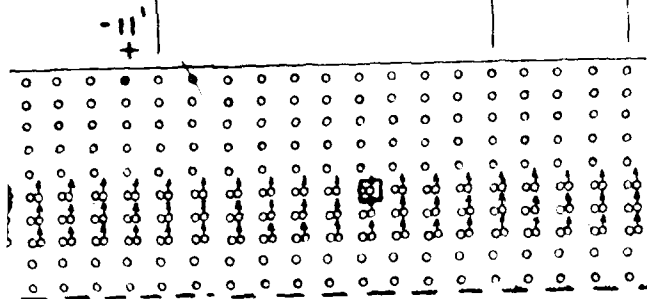
(180)

(40)

(244)

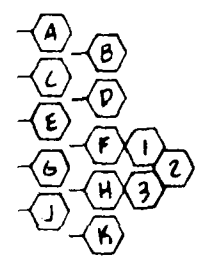
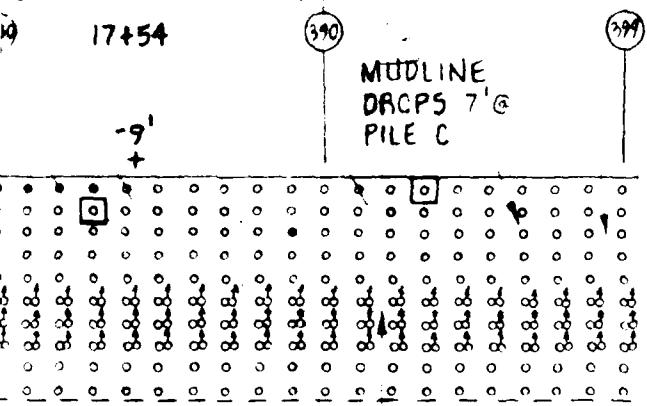
CROSS-SECTIONAL AREA.

4. REFERENCE: HUDSON ENGINEERS REPORT-1976
SHT 18, P.W. DWG NOS. B-1754,
C-1507, C-1513, C-1513, C-13539.



1/4" GAP BETWEEN DECK
PLANKS, SLIGHT SAG IN
DECK PLANKS DETECTED

2" GAP BETWEEN
DECK PLANKS



TIMBER SHEETING

LIMIT OF ACCESS

GRAPHIC SCALE

AS SHOWN

CHILDS ENGINEERING
CORPORATION
BOX 333
MEDFIELD, MA

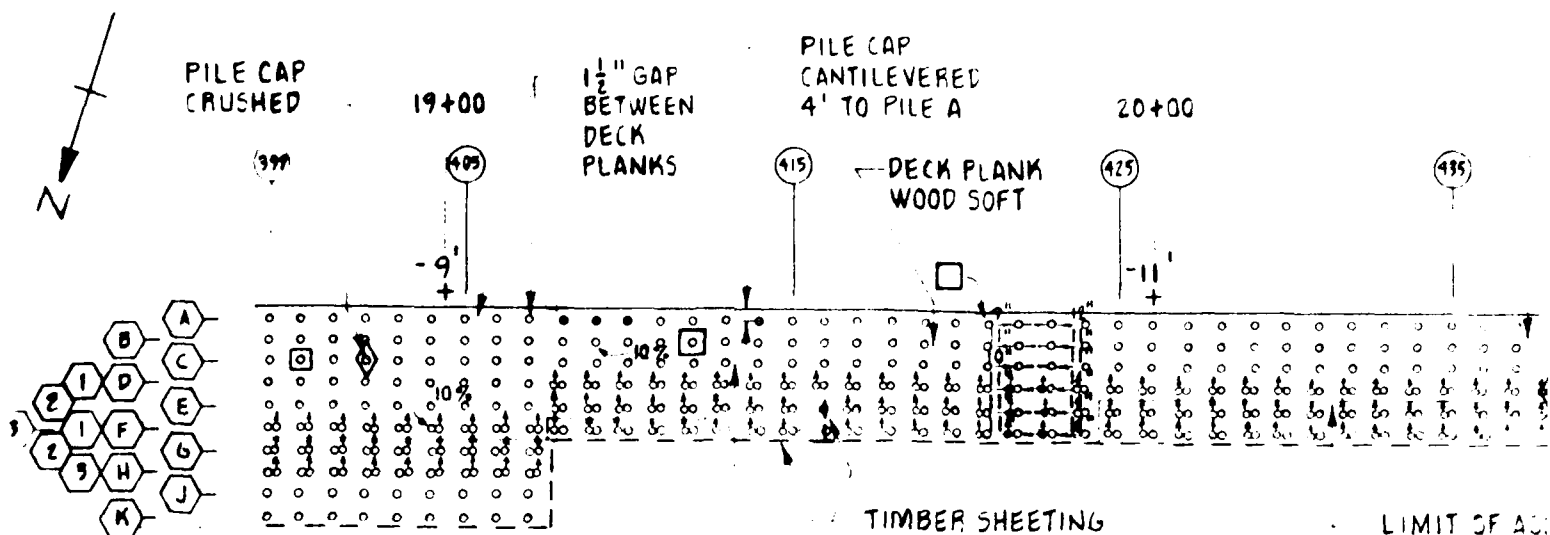
CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C.

PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA

WHARF N

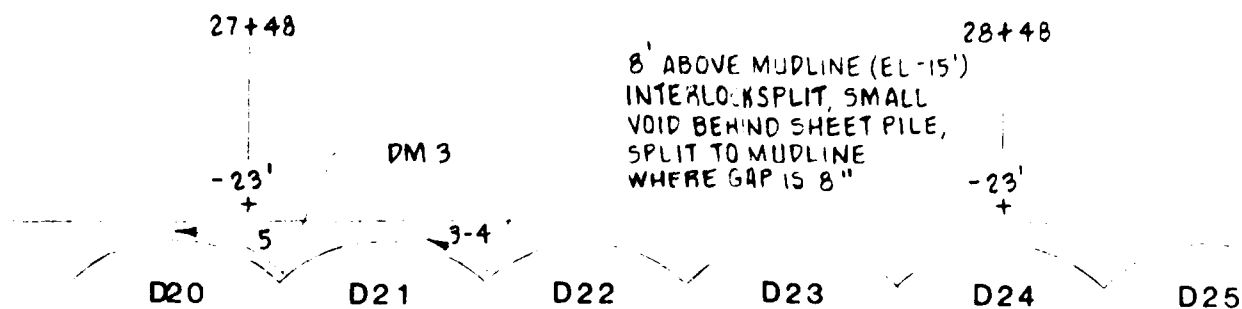
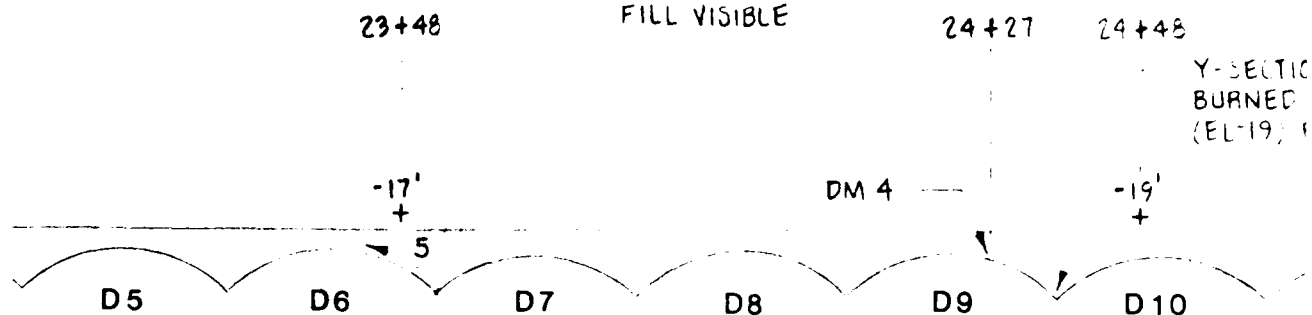
FIG. NO.

90



DECK SAGGING 1/2"

SHEET PILE DEFORMED
12" @ MUDLINE (EL -17),
SMALL HOLE,
FILL VISIBLE



31+48

FACE OF WHARF

EL -7'
12" x 1" LG PIT
1/4" - 1/2" DEEP
ACROSS SHEET

32+48

MUDLINE EL DROPS
10' TO EL -31'
3' FROM FACE OF
CELL

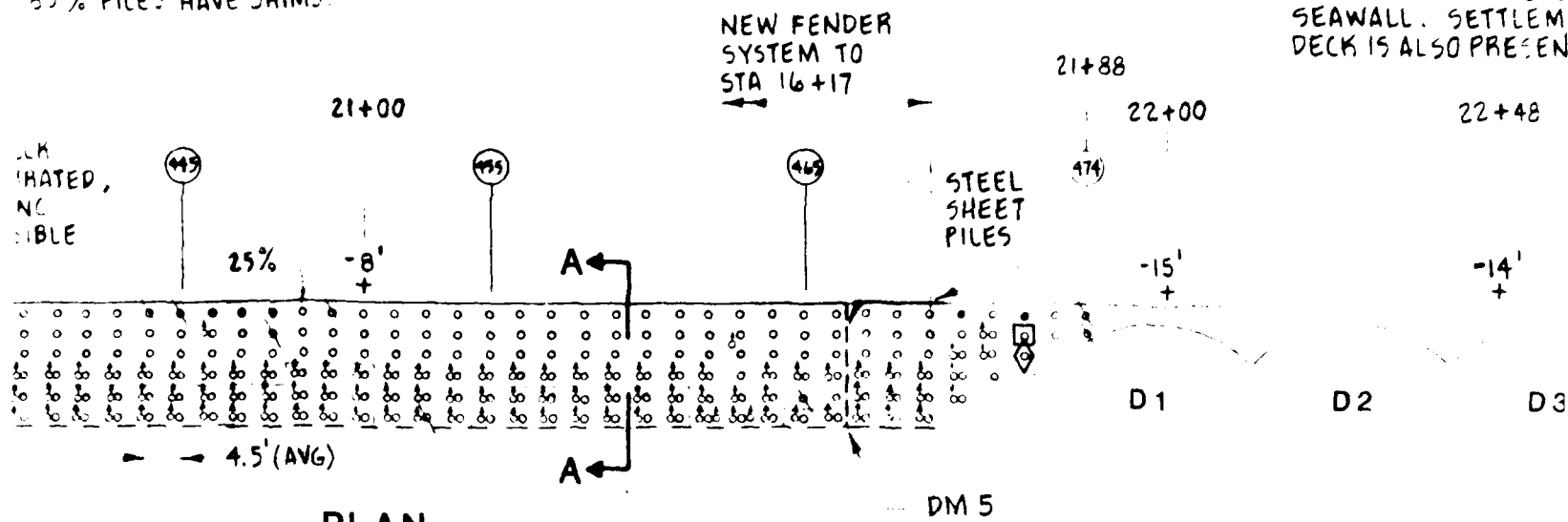
SETTLEM
TOP DECK

-20'

-21'

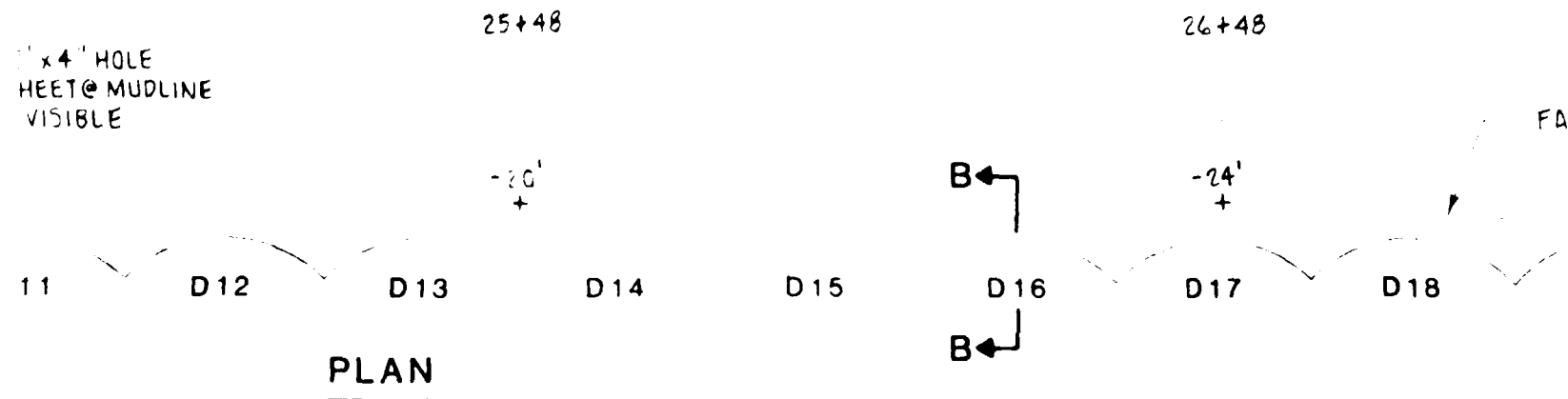
GENERAL NOTE :
80% PILES HAVE SHIMS.

STEEL SHEET PILE CAP
APPROX 1' TO THE S
SEAWALL. SETTLEMENT
DECK IS ALSO PRESEN



PLAN

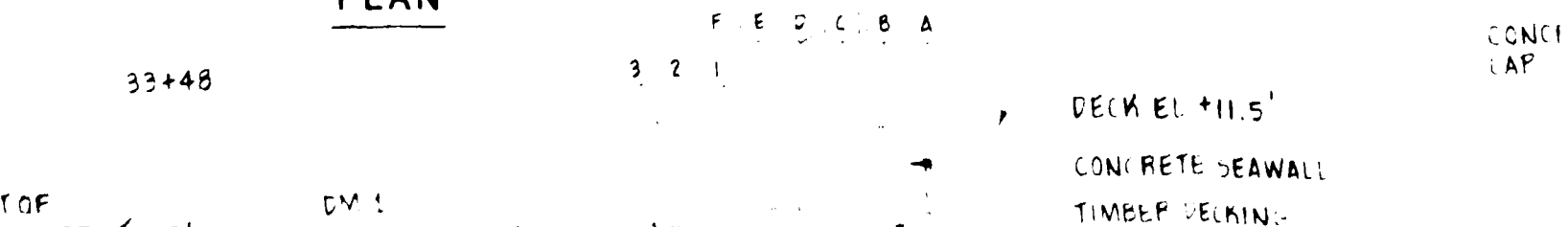
10 5 0 10 20 30 40 50
SCALE OF FEET



PLAN

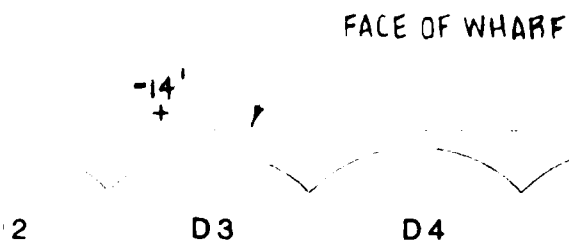


PLAN



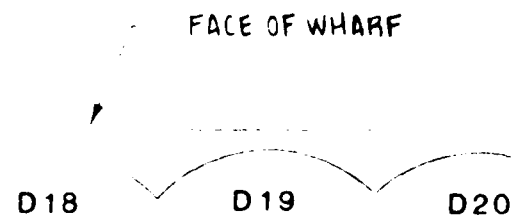
L SHEET PILE CAP OUT OF LINE
 APPROX 1' TO THE SOUTH OF THE
 WALL. SETTLEMENT OF THE TOP
 IS ALSO PRESENT.

22+48



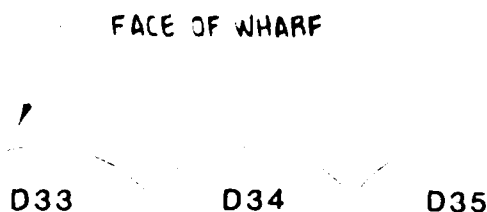
LEGEND

- WILD PILE
- NON-BEARING PILE
- BROKEN PILE
- DISPLACED-SPLIT PILE
- CORE LOCATION (PILE, CAP, DECK) LEVEL 3 INSPECTION
- MINIMUM PILE DIAMETER, LEVEL 2 INSPECTION
- SOUNDINGS IN FEET BELOW MLW
- 50% OF PILE BEARING ON PILE CAP
- TIMBER BEARING PILE
- TIMBER BATTER PILE
- BENT NO. DESIGNATION
- PILE DESIGNATION
- D-METER LOCATION
- CCW COUNTED COUNTERCLOCKWISE FROM WYE SHEET



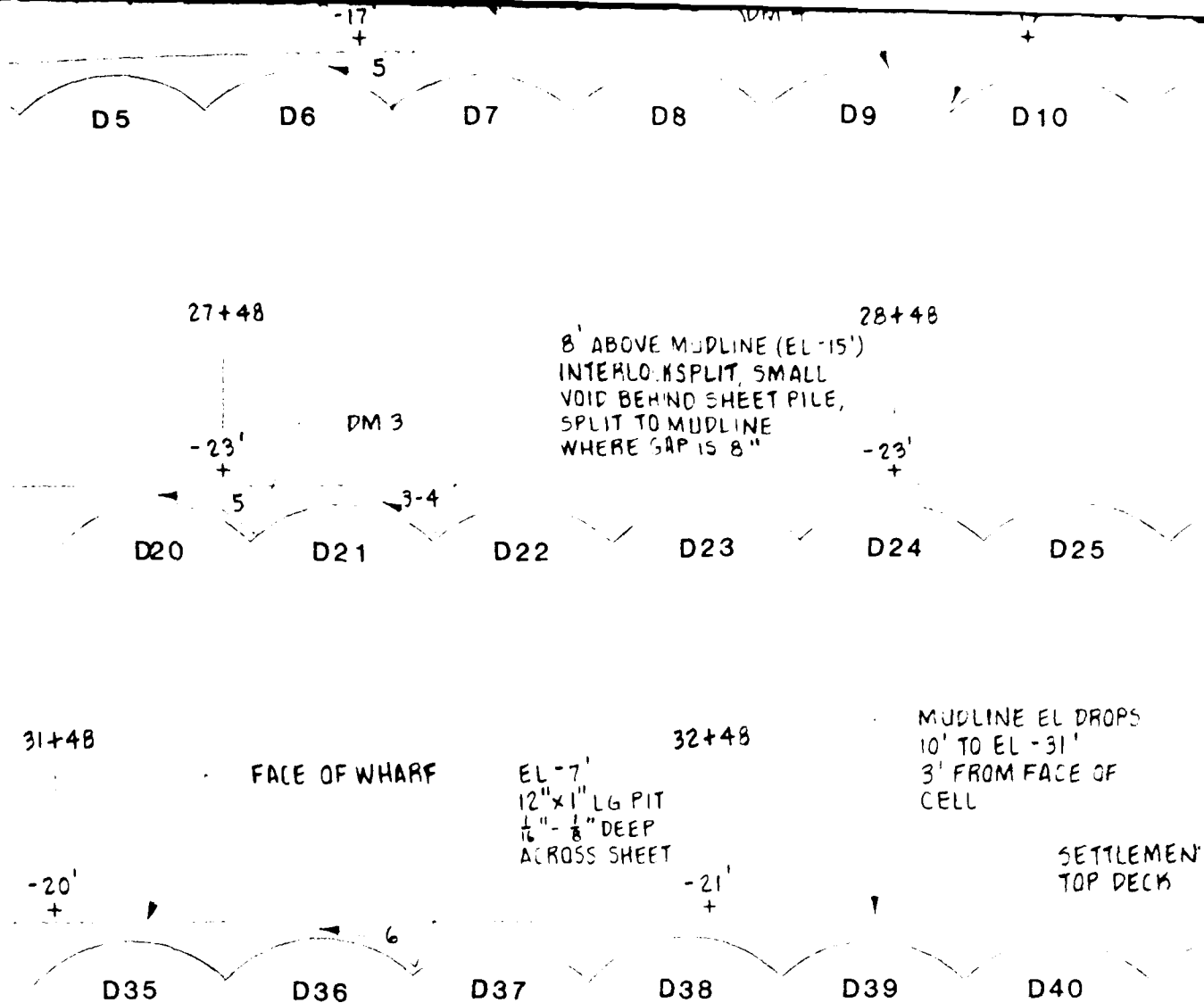
NOTES:

1. LEVEL 1 INSPECTION ON ALL PILES-HIGHER LEVELS OF INSPECTION WHERE NOTED.
2. CORE SAMPLES INDICATE 1" OF SOFTNESS, A TYPICAL CONDITION.
3. 80% OF THE PILES ARE SHIMED.
4. CORROSION NODES FOUND ON THE STEEL SHEET PILES VARY IN SIZE FROM 2" TO 1/2" IN DIA. THE PROTECTIVE COATING IS STILL INTACT ALTHOUGH THE CORROSION NODES ARE PROTRUDING THROUGH THE COATING.
5. REFERENCES: HUDSON ENGINEERS REPORT-1976, SHT 18, PW. DWG NOS B-1754, C-1507, C-1513, C-1514, C-13539



CONCRETE
CAP

DECK EL:
EAST END +13.0'
WEST END +13.6'



PLAN

NOT TO SCALE

STEEL THICKNESS READINGS

DM 1	D 41	SHEET 10 CCW	DM 2	D 31	SHEET 11 CCW	DM 3	D 20	SHEET 1
EL (FT)	READING (IN)		EL (FT)	READING (IN)		EL (FT)	READING (IN)	
+2.0	.520		+2.0	.420		+2.0	.375	NO
0.0	.530		0.0	.395		0.0	.375	
-2.0	.550		-2.0	.375		-2.0	.375	.325
-4.0	.545		-4.0	.385		-4.0	.375	ON
-6.0	.495		-6.0	.400		-6.0	.380	ARE
-10.0	.500		-10.0	.360		-10.0	.375	
-15.0	.535		-15.0	.370		-16.0	.370	
-17.0 (ML)	—		-20.0 (ML)	.395				

DM 5 SHEET PILE BETWEEN BENTS 8-9

EL (FT)	READING (IN)	
+1.0 (TOP)	.395	GOOD CONDITION
-4.0	.270	
MUDLINE	.350	

D11 D12 D13 D14 D15 D16 D17 D18

PLAN

29+48

30+48

-23'
+

-20'
+

DM 2

D26

D27

D28

D29

D30

D31

D32

PLAN

33+48

3 2 1

ENT OF

DM 1

-19'
+

D41

10

TIMBER
SHEETING

DECK EL +11.5'

CONCRETE SEAWALL

TIMBER DECKING

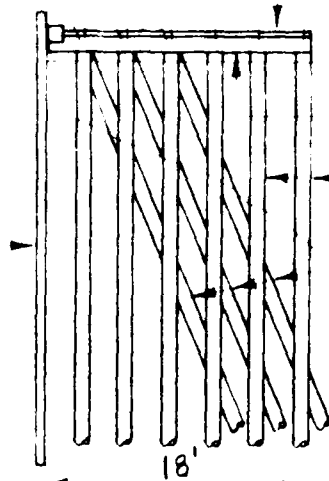
MLW EL +0.6'

PILE CAP

BEARING PILES

BATTER PILES

MUDLINE (EL VARIES)



SECTION A-A

10

0

10

20

SCALE OF FEET

T 500W

DM 4

D 9

STA 24+27

ION N
CORROSION)
250-2.4
PITTED
HEADS

EL. FT)

READING (IN)

+2.0	.500
0.0	.490
-2.0	.445
-4.0	.495
-6.0	.490
-10.0	
-15.0	.455
-21.0 (ML)	.495

1. LEVEL 1 INSPECTION ON ALL PILES - HIGHER LEVELS OF INSPECTION WHERE NOTED.
2. CORE SAMPLES INDICATE 1" OF SOFTNESS, A TYPICAL CONDITION.
3. 80% OF THE PILES ARE SHIMED.
4. CORROSION NODES FOUND ON THE STEEL SHEET PILES VARY IN SIZE FROM 2" TO 1/4" IN DIA. THE PROTECTIVE COATING IS STILL INTACT ALTHOUGH THE CORROSION NODES ARE PROTRUDING THROUGH THE COATING.
5. REFERENCES: HUDSON ENGINEERS REPORT-1976, SHT 18, P.W. DWG NOS B-1754, C-1507, C-1513, C-1514, C-13539

18 D19 D20

FACE OF WHARF

D33 D34 D35

CONCRETE
CAP

DECK EL:
EAST END +13.0'
WEST END +13.6'

MLWEL +0.6'

STEEL SHEET
PILING

MUDLINE
(EL VARIES)

SECTION B-B

SCALE: SIMILAR

GRAPHIC SCALE

AS SHOWN

CHILDS ENGINEERING
CORPORATION
BOX 333
MEDFIELD, MA

CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C.

PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA FILE NO.

WHARF N

91

4.20.2 OBSERVED INSPECTION CONDITION

A list of quantities of the specific anomalies discovered during the inspection is as follows:

- 92 - Broken piles
- 50 - Split and displaced piles
- 8 - Non-bearing piles
- 8 - Partially-bearing piles
- 2 - Wild piles

The locations of these specific anomalies can be found on Figures 90 and 91.

Generally the timber piles, caps and deck inspected along Wharf N were found to have 1" of softness. In some locations up to 3" of softness were detected on the timber piles. The minimum diameter of the timber piles has not changed since the piles were driven. The smallest minimum diameter measured is 9". On the older section of the wharf (Sta. 0+00 to 9+90) there is heavy corrosion on the fasteners. Up to 50% of the cross-section of steel is deteriorated. The pile cap at Pile C, Bent 402 is damaged. In its present condition the pile cap is not functional (see Photo #72).

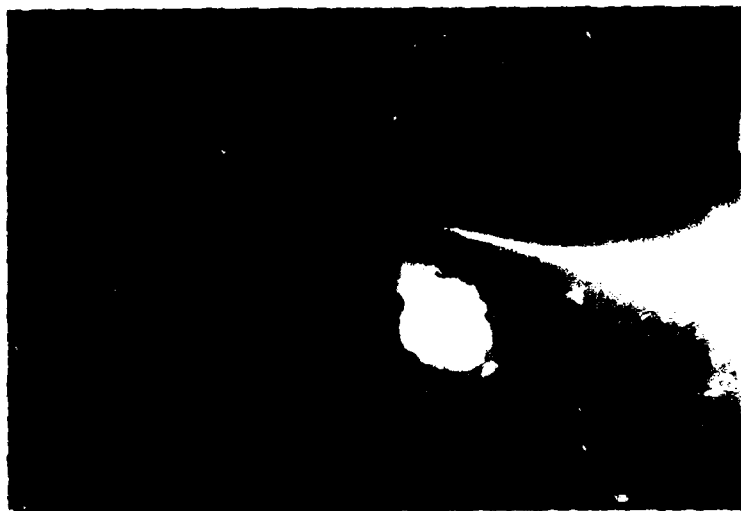
Access to the timber sheet pile was limited due to the elevation of the mudline. The portions of the timber sheet pile which were inspected were found to be sound with minimal timber softness. Large (2" diameter) orange corro. on nodes were found to be protruding through the protective coating of the steel sheet piles. Upon removal of a corrosion node, pitting of approximately 1/16" deep of the steel is observed. The area surrounding the



PHOTO NO. 72: Wharf N, Bent 402, Pile C;
illustrates crushed cap just below
decking. Note algal growth. Cap
is approx. 12" high.

corrosion nodes is clear of corrosion with the protective coating intact (see Photo #73). As the steel thickness measurements indicate, there has been minimal loss of steel due to corrosion. Other anomalies found along the steel sheet pile diaphragm wall include slight deformation of sheets at the mudline (Sta. 23+48), a small hole burned in the sheeting (24+31) (see Photo #74), a split interlock at the mudline (27+75) and a large pit approximately 1' long across a sheet (31+95) which is assumed to be the result of a scratch in the protective coating (see Photo #75). At the junction of the diaphragm cell construction and the timber pile relieving platform there is a bulge in the wharf face, south of the concrete seawall and steel sheet pile cap. The bulge is approximately 12" outshore over 70'. Associated with this bulge is a cracking of the concrete.

PHOTO NO. 73: Wharf N, Cell 36, El. -5';
illustrates typical nodular
corrosion through steel coating.
Note chipping hammer to the left,
black coating still intact.



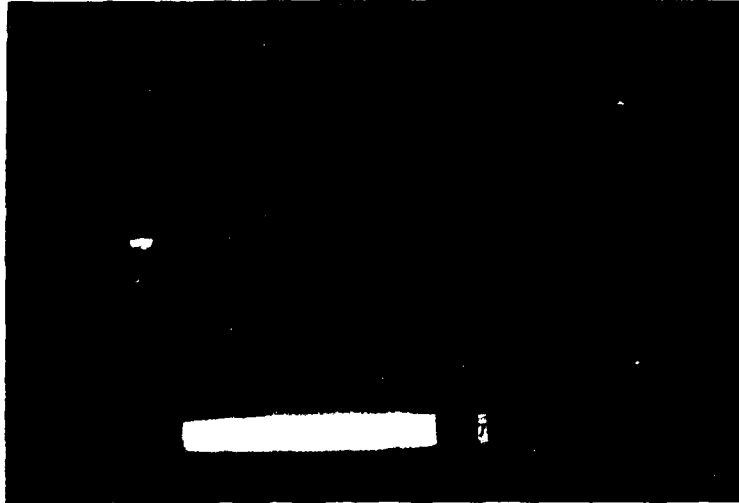
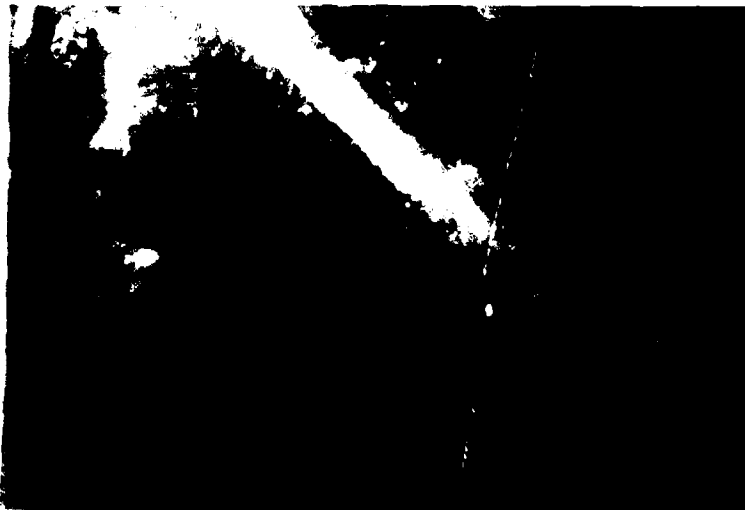


PHOTO NO. 74: Wharf N, Cells 9-10; hole is in the wye pile between the two cells. Hole is not the result of corrosion.

PHOTO NO. 75: Wharf N, Cell 36, Sheet 6, counter-clockwise, El. -7'; portion of a large S-shaped pit in steel sheet pile.



4.20.3 STRUCTURAL ASSESSMENT

Damaged piles which are located near the perimeter of the wharf are assumed to be a result of excessive berthing and mooring forces. The fendering camels used in these areas transmit horizontal loads to the perimeter piles instead of the fender system which has deteriorated. Anomalies occurring at the interior of the wharf are assumed to be a result of forces generated by minor settlement, debris trapped below the relieving platform, or during construction.

The softness of timber found throughout the wharf is apparently a result of the age of the structure. Calculations incorporating reduced areas due to softness (see Appendix A-9 to A-11) indicate that the timber piles are fully capable of supporting the designated live-load of 200 psf.

The steel sheet pile diaphragm structure has lost little cross-sectional area due to corrosion and is fully capable of supporting the designated live-load of 200 psf. The anomalies noted on Figure 91 in relation to the steel sheet pile, apparently are construction-related and have no effect on the integrity of the structure. Where the relieving platform and the diaphragm structure meet there is a bulge in the top deck face. This bulge is assumed to be a result of the interface between construction methods and materials. It appears that the relieving platform structure existed prior to the placement of the sheet pile cells. In driving Cell N1 the relieving platform was cut to facilitate

its placement. The settlement or bulge apparently occurred subsequent to the new construction. It is assumed that this bulge is stabilized and is not an indication of impending failure. However, the alignment of the seawall and pile cap should be monitored to detect any further movement to the south.

4.20.4 RECOMMENDATIONS

The 92 broken piles should be replaced or long-posted as needed. The estimated cost to replace one pile is \$1,000. The total estimated cost is \$92,000. The 50 split and displaced piles, 8 non-bearing piles, 8 partially-bearing piles and 2 wild piles should be posted, repositioned and refastened to the pile cap as needed. The estimated cost per pile is \$400. The total estimated cost is \$27,200. The damaged pile cap at Bent 402 should be repaired with a sistered cap (see Appendix A-24) at an estimated cost of \$500. The bulge at Sta. 21+88 should be monitored to detect any movement to the south.

If the wharf is to be used as a mooring for inactive ships, berthing/mooring forces are to be expected. A fender system should be installed and the use of fendering camels should be discontinued.

Live-loading in deck areas directly associated with damaged (broken, split and wild) piles should be restricted to 25% of the current recommended live-load capacity until those piles are repaired. Following implementation of the recommended repairs, live-loading can be maintained at current levels (200 psf).

The timber portions of the wharf (Sta. 0+00 to 21+88) should be inspected after repairs and on a two-year basis thereafter. This will enable Shipyard personnel to monitor the timber softness and determine when critical limits have been reached. The remainder of the wharf should be inspected after repairs and on a 6-year basis thereafter. The estimated remaining life of Wharf N is in

excess of 20 years. This report should be used as a baseline for future inspections.

APPENDIX

CALCULATIONS

Average capacity of relieving platform structure . . .	A-1 - A-7
Timber pile data summary	A-8
Typical reduced timber capacity due to softness . . .	A-9 - A-11
Timber sheet pile analysis	A-12 - A-13
Wharf F and Pier F calculations	A-14 - A-15
Broad St. Wharf calculations	A-16 - A-18
Wharf L reduced pile capacity	A-19

CONCEPTUAL DESIGN

Replacement timber pile	A-20
Refastening of timber pile	A-21
Posted timber pile	A-22
Timber pile long post	A-23
Pile cap sister	A-24
Broad St. detail	A-25
Seawall detail	A-26
Partially-bearing pile	A-27
Cost estimate breakdowns	A-28
References	A-29
Points of Contact	A-30

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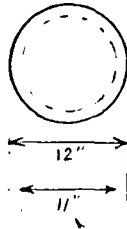
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SCALE _____

THE MAJORITY OF THE FACILITIES AT THE PHSY
CONSIST OF THE LOW DECK, EARTH FILL, TIMBER PILE
SUPPORTED, RELIEVING PLATFORM STRUCTURE. GENERALLY
THE BENT SPACING IS 4' ON CENTER AND THE
PILE SPACING IS 4' ON CENTER. DUE TO LOOSE
QUALITY CONTROL DURING THE CONSTRUCTION OF SOME
FACILITIES, ON A REGULAR BASIS THE BENT SPACING
IS AS MUCH AS 5' AND THE PILE SPACING IS ALSO
5'. THESE MAXIMUM SPACINGS ARE NOT TYPICAL AND
ARE NOT CONTROLLING FACTORS. THE FOLLOWING
CALCULATIONS HAVE TAKEN THE AVERAGE EXISTING
CONDITION AND DETERMINED THE LIMITING CAPACITIES
WITH RESPECT TO THE TOP DECK LIVE LOAD CAPACITY.
ALSO IN THE APPENDIX ARE ANALYSES OF SPECIAL
ANOMALIES AND NON-TYPICAL CONDITIONS.

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SCALE: _____



DETERMINE TIMBER PILE COLUMN CAPACITY

ASSUME :

$$E = 1.6 \times 10^6 \text{ \#/IN}^2$$

$$L = 480'' = 40'$$

$$K = .7$$

$$r = 2.75 \text{ IN}$$

REDUCED PILE DIAMETER
DUE TO TIMBER WETNESS

FROM THE TIMBER CONSTRUCTION MANUAL

USE:
$$F_c' = \frac{3.619 E}{\left(\frac{KL}{r}\right)^2} \quad \text{K12}$$

$$F_c' = 387 \text{ \#/IN}^2$$

$$F_c = 387 \text{ \#/IN}^2 (.9) \quad \leftarrow \text{DURATION OF LOAD FACTOR}$$

$$F_c = 348 \text{ \#/IN}^2$$

$$P = F_c A$$

$$P = (348 \text{ \#/IN}^2) \quad 95 \text{ IN}^2$$

$$P = 33 \text{ K} = 16.5 \text{ TONS}$$

16.5 COLUMN CAPACITY > 15 T DRIVE CAPACITY

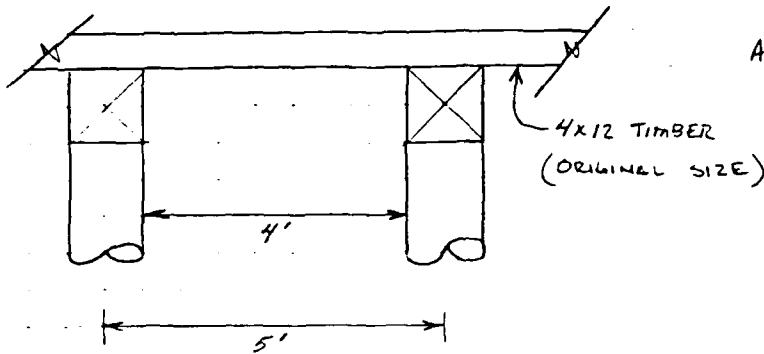
THEREFORE THE DRIVEN CAPACITY IS LIMITING

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DETERMINE DECK TIMBER CAPACITY



ASSUME: $F_b = 1650 \text{ #/IN}^2$
 $M_{max} = \frac{W L^2}{12}$

$F_v = 120 \text{ #/IN}^2$
 $F_{CL} = 315 \text{ #/IN}^2$
 $L = 48"$

REDUCED SECTION = $3\frac{1}{2} \times 11\frac{1}{4}$

BENDING

$S = 23 \text{ IN}^3$
 $M_{max} = S F_b \cdot 9$ — DURATION OF LOAD FACTOR
 $W_{max} = 34 \text{ IN K}$

$W = \frac{12 M_{max}}{L^2}$

$W = .17 \text{ K/IN} = 2.13 \text{ K/FT}$

HORIZ. SHEAR

FOR RECTANGULAR BEAMS $F_v = \frac{3V}{2A}$

$W = \frac{2 F_v A \cdot 9}{3 L}$ (2) $L' = 40"$

$W = .14 \text{ K/IN} = \underline{1.68 \text{ K/FT}} \text{ LIMITING.}$

CRUSHING

AREA OF BEARING 144 IN^2 — DURATION OF LOAD

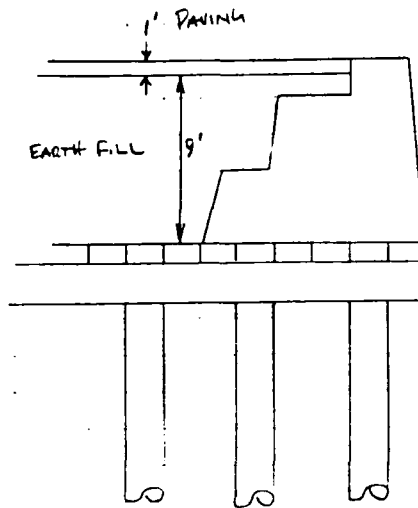
$W = \frac{(315 \text{ #/IN}^2)(144 \text{ IN}^2) \cdot 9 \cdot (.67)}{60 \text{ IN}}$ — CRUSHING LIMITING FACTOR

$W = 455 \text{ #/IN} = 5.46 \text{ K/FT}$ — TCM P.270 TABLE 2.14 g

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SCALE _____



DETERMINE UNIT DEAD LOAD IMPOSED BY LOW DECK, EARTH FILL, RELIEVING PLATFORM STRUCTURE.

$$\begin{aligned} \text{WEIGHT OF PAVING} &= 150 \text{ #/ft}^2 = 150 \text{ #} \\ \text{WEIGHT OF EARTH FILL} &= 125 \text{ #/ft}^3 @ 9 \text{ ft} = 1125 \text{ #} \\ &(\gamma_{\text{SAT}} = 125 \text{ #/ft}^3) \\ \text{WEIGHT OF 4" DECK} &= 64 \text{ #/ft}^2 @ .33 \text{ ft} = 21 \text{ #} \\ &\hline 1296 \text{ #/ft}^2 \end{aligned}$$

$$\text{WEIGHT OF PILE CAP} = 64 \text{ #/ft}^2 @ 4 \text{ ft} = 256 \text{ #}$$

- IN CONSIDERING THE DL ON TIMBER PILES AND TIMBER PILE CAPS USE A UNIT LOAD OF 1.5 K/ft^2
- IN CONSIDERING THE DL ON THE TIMBER DECKING USE A UNIT LOAD OF 1.3 K/ft^2

IN ASSUMING MAXIMUM BENT SPACING OF 5' AND A
PILE SPACING OF 4' WE CAN DETERMINE THE
ALLOWABLE LIVE LOAD CAPACITY

LIMITING FACTORS -

PILECAP - 8 K/FE

DECK PLANK - 1.68 K/FE²

TIMBER PILE - 30 K

- THE DL ON THE TIMBER PILE IS 1.5 K/FE²; ASSUME
AN AREA OF 16 FE² IS SUPPORTED BY 1 PILE DUE TO
THE TYPICAL LOAD DISTRIBUTION.

$$\text{TOTAL DL} = 24 \text{ K}$$

$$\text{ALLOWABLE LOAD} = 30 \text{ K / PILE}$$

$$\text{LL} = 30 \text{ K} - 24 \text{ K} = 6 \text{ K}$$

$$\text{LL} = 375 \text{ PSF}$$

IF THE ALLOWABLE LOAD IS 40 K / PILE
THEN LL = 1000 PSF

- THE DL ON THE PILE CAP IS 1.5 K/FE²; ASSUME
AN AREA OF 16 FE² IS SUPPORTED.

$$\text{TOTAL DL} = 24 \text{ K}$$

$$\text{ALLOWABLE LOAD FOR 4' SPAN} = 32 \text{ K}$$

$$\text{LL} = 32 \text{ K} - 24 \text{ K} = 8 \text{ K}$$

$$= 500 \text{ \#/FE}^2$$

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SHEET NO. 6 OF 6
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THE DL ON THE DECK PLANKING IS 1.3 K/FT²
WITH A 5' BENT SPACING; THE LENGTH
OF DECK PLANK UNDER CONSIDERATION IS 3.33'

$$\text{TOTAL DL} = 4.3 \text{ K}$$

$$\text{TOTAL ALLOWABLE LOAD} = 5.5 \text{ K}$$

$$\begin{aligned} \text{LL} &= 5.5 \text{ K} - 4.3 \text{ K} = 1.2 \text{ K} \\ &= 388 \text{ \#/FT}^2 \end{aligned}$$

IN THE TYPICAL RELIEVING PLATFORM STRUCTURE
THE TIMBER DECKING IS THE CAPACITY WHICH
LIMITS THE LIVE LOADING. THE CALCULATIONS
SHOW THAT 388 #/FT² IS THE MAXIMUM LL
THAT THE TYPICAL RELIEVING PLATFORM CAN HANDLE.
ALTHOUGH, IF THE PILE SPACING AND BENT SPACING
ARE LESS THAN 4' AND 5' RESPECTIVELY, THE CAPACITY
OF THE RELIEVING PLATFORM IS MUCH GREATER.

TIMBER PILE DATA SUMMARY

<u>FACILITY</u>	<u>**RANGE OF STRUCTURAL TIMBER SOFTNESS DETECTED</u>	<u>RANGE OF PILE DIAMETERS OBSERVED</u>	<u>TIMBER PILE DRIVEN CAPACITY***</u>
Eastern Seawall	3/4" ave.	11" - 15"	3 - 20
Pier 7	2" - 6"	10" - 15"	15
Pier 1 & Bulkhead	1" ave.	11"	15
Pier 2	1" - 2"	10" - 14"	15
Wharves 4A & 4B	3/4" ave.	9" - 14"	15
Pier 4	1/2" ave.	9" - 13"	15 - 20
Pier 5	1/4" - 1/2"	10" - 17"	20
Barge Basin & Bkhd	1/2" - 1"	9" - 14"	15
Pier 6	1/4" - 1"	10" - 14"	15
Pier 6A-Bulkhead	1" - 4"	10" - 13"	15
DD Wharves	1/2" ave.	11" - 18"	15
Wharves K,J,I,H,G	1/2" ave.	10" - 16"	15
Wharf F/Pier F	1/2" - 1"	11" - 15"	15
Wharf E	1/2" - 1 1/2"	9" - 14"	15
Rowan Ave.	NA*	NA*	NA*
2nd Street	1 1/2" - 3"	9" - 12"	15
Preble Ave.	1 1/2" - 2"	8" - 10"	15
Broad Street	1 1/2" - 3"	11" - 14"	15
Wharf L	1/2" - 1 1/2"	9" - 10"	15
Wharf N	1" - 3"	9" - 14"	15

* NA = Not Applicable

** For detailed account of timber softness, i.e., variations between piles, caps, decking; see individual facility's Observed Inspection Condition.

*** Timber pile driven capacities have been extrapolated from GFI such as the Hudson Engineers Report or actual NAVFAC or PW drawings.

TYPICAL TIMBER SOFTNESS

PIER 7

DETERMINE REDUCED CAPACITY OF TIMBER PILE CAP DUE TO TIMBER SOFTNESS.

$$\begin{aligned} F_b &= 1650 \text{ #/in}^2 \\ F_v &= 120 \text{ #/in}^2 \\ F_{cl} &= 315 \text{ #/in}^2 \\ L &= 48'' \end{aligned}$$



ORIGINAL 12x12 CAP
 $A = 144 \text{ in}^2$

AREA OF TIMBER REMAINING
AFTER A REDUCTION
IS CONSIDERED.

ASSUME $A' \approx 95 \text{ in}^2$

BENDING

$$\begin{aligned} S &= 130 \text{ in}^3 \\ M_{max} &= S F_b \cdot 9 \\ M_{max} &= 193 \text{ IN-K} \end{aligned}$$

DURATION OF LOAD FACTOR

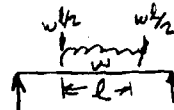
$$W = \frac{12 M_{max}}{L^2} = 12.1 \text{ K/FT}$$

HORIZ. SHEAR

$$\text{USE } F_v = \frac{3V}{2A}$$

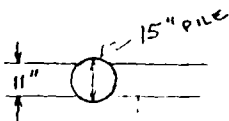
$$\text{WHERE } V = \frac{Wl}{2}$$

$$W = \frac{2 F_v A' \cdot 9}{3L} (2) = \underline{\underline{6.3 \text{ K/FT}}}$$



$$L = 6$$

CRUSHING



PILE CAP

ASSUME AREA OF BEARING $A' \approx 165''$

MOISTURE CONTENT
REDUCTION FACTOR

$$W = \frac{(315 \text{ #/in}^2)(165'') \cdot 9 \cdot 0.67}{48 \text{ IN}} = 7.8 \text{ K/FT}$$

$$W = \frac{F_{cl} \cdot A' \cdot 9 \cdot 0.67}{L}$$

A-9

TYPICAL TIMBER SOFTNESS

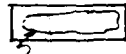
PIER 7

DETERMINE REDUCED CAPACITY OF TIMBER DECKING
DUE TO SOFTNESS.

$$F_b = 1650 \text{ #/IN}^2$$

$$F_v = 120 \text{ #/IN}^2$$

$$F_{CL} = 315 \text{ #/IN}^2$$



ORIGINAL 4X12 DECKING

AREA = TIMBER REMAINING AFTER A REDUCTION
IS CONSIDERED

$$\text{ASSUME } A' \approx 30 \text{ IN}^2$$

BENDING

$$S = 15 \text{ IN}^3$$

$$M_{max} = S F_b \cdot 9$$

$$W_{bending} = 22.2 \text{ K/FT}$$

DURATION OF LOAD FACTOR

$$W = \frac{12 M_{max}}{L^2} = 1.37 \text{ K/FT}$$

HORIZ. SHEAR

$$W = \frac{2 F_v A' \cdot 9}{3 L} = 1.23 \text{ K/FT}$$

CRUSHING

$$\text{AREA OF BEARING } 120 \text{ IN}^2$$

$$W = \frac{(315 \text{ #/IN}^2)(120 \text{ IN}^2) \cdot 9 \cdot 0.68}{60 \text{ IN}} = 4.6 \text{ K/FT}$$

MOISTURE CONTENT
REDUCTION FACTOR

WE CONCLUDE THAT THE LIMITING FACTOR ON
PIER 7 IS THE HORIZONTAL SHEAR CAPACITY OF
THE REDUCED SECTION OF THE DECK PLANK

- WHEN LOADING ON THE DECK PLANK IS ANALYSED THE
DL = 1.3 K/FT² > ALLOWABLE LOAD = 1.23 K/FT²
- THIS IS A CONDITION OF IMPENDING FAILURE -

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JOB 498-82-F PMSY

SHEET NO 1 OF 1

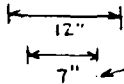
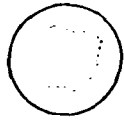
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CHECKED BY FNT DATE

SCALE NONE

REDUCED TIMBER PILE CAPACITY

(BULKHEAD BETWEEN PIER 6 AND PIER 6A)



REDUCED CAPACITY
DUE TO TIMBER SOFTNESS

ASSUME: $E = 1.6 \times 10^6 \text{ #/IN}^2$
 $L = 15' = 180"$
 $K = .7$
 $\gamma = 1.75 \text{ IN}$

FROM AITC USE:

$$F_c' = \frac{3.619 E}{\left(\frac{KL}{r}\right)^2}$$

$$F_c' = 1.1 \text{ KSI}$$

$$F_c = 1.1 \text{ KSI} (.9) \leftarrow \text{DURATION OF LOAD FACTOR}$$

$$F_c = .99 \text{ KSI}$$

$$P = F_c A$$

$$P = .99 \text{ KSI} (38.5 \text{ IN}^2)$$

$$P = 38.1 \text{ K} = 19 \text{ T}$$

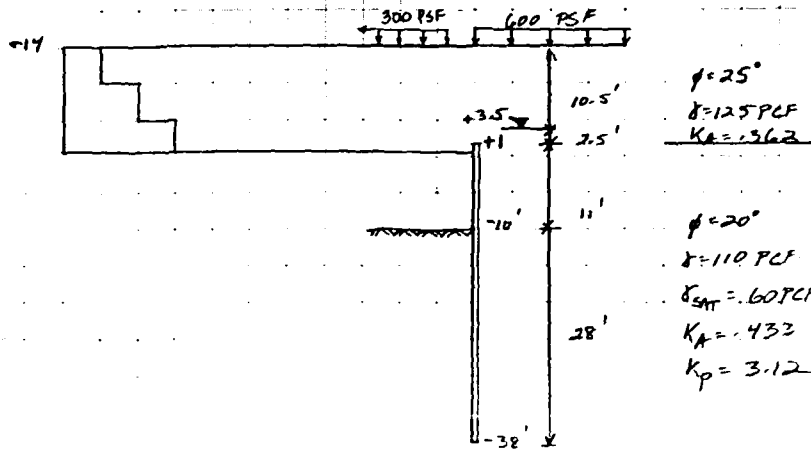
19T COL. CAP. > 15T DRIVEN CAP

∴ DRIVEN CAPACITY IS LIMITING

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JOB 11111
SHEET NO 1 OF 2
CALCULATED BY FATZ DATE 1/9/84
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SCALE _____

TIMBERL SHEET PILE ANALYSIS



$$\begin{aligned}\text{SURCHARGE ACTING @ EL } +1 &= 600 \text{ PSF} + \text{WT SOIL} \\ &= 600 \text{ PSF} + (10.5' \times 125 \text{ PCF}) + (2.5') (60 \text{ PCF}) \\ &= 2063 \text{ PSF}\end{aligned}$$

DETERMINE X - PT OF CONTRAFLEXURE

$$\begin{aligned}\text{FOR } \phi = 20^\circ \quad X &= 0.1 H' \quad H' = 11 + \frac{P}{\gamma} = 11 + \frac{2063}{125} = 27.5 \\ X &= 2.8\end{aligned}$$

$$L = H_T + X = 11 + 2.8 = 13.8'$$

CALCULATE TOTAL LOAD W ON L

$$W = \left(\frac{893 + 1179}{2} \right) (11) + \left(\frac{1179 + 728}{2} \right) (2.8) = 14,065 \text{ LB/FT RUN WALL}$$

BENDING

$$M_{MAX} = \frac{WL^2}{8} = \frac{(14.1 \text{ K})(13.8')^2}{8} = 24.3 \text{ FT-K}$$

USING 11.5 x 11.5 X-SECTION

$$S = 253.5 \text{ IN}^3 \quad F_b = 1650 \text{ PSI}$$

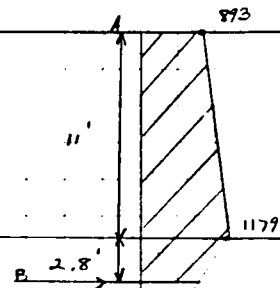
$$(S)(F_b)(1.9) = 31.4 \text{ FT-K} > 24.3 \text{ FT-K} \quad \checkmark$$

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JOB _____
SHEET NO. 2 OF 2
CALCULATED BY FATZ DATE 1/9/87
CHECKED BY _____ DATE _____
SCALE _____

COL 1	COL 2	COL 3	COL 4	COL 5
γ_h 2963	γ_h -	γ_{wh} -	P_A 893	P_P -
2723	0	-	1179	0
4403	1680	-	1906	5242



3336

HORIZONTAL SHEAR

$$\sum M_A = 0$$

$$(893)(11)(5.5) + \frac{(286)(11)(7.3)}{2} + \frac{(728)(2.8)(12.4)}{2} + \frac{(451)(28)(11.7)}{2} = 13.88$$

$$B = 7.1 \text{ K}$$

$$V_{ALL} = \frac{F_{LL} 2A}{3} = (120 \text{ PSI}) \left(\frac{2}{3} \right) (11.5^2)$$

$$= 10.6 \text{ K} > 7.1 \text{ K} \quad \checkmark$$

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JOB 498-82 F PHILA
SHEET NO 2 OF 2
CALCULATED BY CDS DATE 2/22/84
CHECKED BY RGF DATE 3/24
SCALE

WHARF-F PIER F

ALLOWABLE LOAD PER ft^2 DUE TO THE DRIVEN
CAPACITY OF THE PILE:

$$4' \text{ BENT SP} \times 3.25' \text{ PILE SP} = 13 \text{ ft}^2$$

$$\text{ASSUMED PILE CAPACITY} = 30 \text{ K}$$

$$\text{PILE CAPACITY} / \text{SF} = \frac{30 \text{ K}}{13 \text{ ft}^2} = 2.3 \text{ K/ft}^2$$

$$\text{CAPACITY} - \text{DL} = \text{LL}$$

$$2.3 - 1.5 = \underline{.8 \text{ K/ft}^2} \quad \text{LIMITING LIVE LOAD FACTOR}$$

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JOB PHILA 498-82
SHEET NO 1 OF 3
CALCULATED BY CDS DATE 2/16
CHECKED BY RGF DATE 3/84
SCALE _____

BROAD ST WHARF

DEAD LOAD

PAVING -	.5' @	150 #/ft ³	=	75 #/ft ²
EARTH FILL -	9.17' @	125 #/ft ³	=	1146 #/ft ²
DECKING -	.33' @	60 #/ft ³	=	20 #/ft ²
PILE CAP -	1/5' @	60 #/ft ³	=	12 #/ft ²

TOTAL DL = 1253 #/ft²
USE 1260 #/ft²

LOAD ON TIMBER PILE

THE MAXIMUM DECK AREA SUPPORTED BY ONE
TIMBER PILE IS 4' x 6' = 24 ft²

$$\text{TOTAL DL} = (1260) 24 = 30240 \#$$

LOAD ON PILE CAP

THE PILE CAP IS SUPPORTING THE SAME LOAD
AS THE TIMBER PILE.

$$\text{TOTAL DL} = 30240 \#$$

LOAD ON DECK PLANK

THE LOAD ON THE DECK PLANKING WILL
BE ASSUMED TO BE 1260 #/ft².

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JOB: PHILA 41X 82

SHEET NO. 3

CALCULATED BY: CDS

DATE: 2/16

CHECKED BY: RGF

DATE: 3/24

SCALE:

BROAD ST WHARF

PILE CAP CAPACITY

BENDING -

ASSUME: - 11" x 11" SECTION DUE TO SOFTNESS

$$- S = 221 \text{ IN}^3$$

$$- M_{\text{MAX}} = \frac{w l^2}{12}$$

$$- F_b = 1650 \text{ PSI}$$

- USE DURATION OF LOAD FACTOR .9

$$\text{IF } M_{\text{MAX}} = S F_b .9$$

$$M_{\text{MAX}} = 328185 \text{ IN-LB}$$

$$\text{THEN } M_{\text{MAX}} = \frac{w l^2}{12}$$

$$w = \frac{12 M_{\text{MAX}}}{l^2} \quad \text{WHERE } l = 60"$$

$$w = 1094 \text{ LB/IN}$$

$$= 13.2 \text{ K/FT} / 4\text{FT} = 3.3 \text{ K/FT}^2 \text{ (CAPACITY)}$$

HORIZONTAL SHEAR -

$$\text{USING: } F_v = \frac{3V}{2A} \quad \text{AND } V = \frac{w l}{2}$$

$$\text{IF: } F_v = 120 \text{ PSI}$$

$$A = 121 \text{ IN}^2$$

$$l = 48 \text{ IN}$$

$$w = \frac{F_v A (2)(2)}{3 l} \quad .9 \text{ FACTOR OF DURATION}$$

$$\text{THEN: } w = 363 \text{ LB/IN}$$

$$= 4.4 \text{ K/FT} / 4\text{FT} = 1.1 \text{ K/FT}^2 \text{ (CAPACITY)}$$

$$- 1.3 \text{ K/FT}^2 \text{ (DL)}$$

$$= .2 \text{ K/FT}^2$$

$$\text{IF: } F_v = 160 \text{ PSI}$$

$$A = 121 \text{ IN}^2$$

$$l = 48 \text{ IN}$$

$$\text{THEN: } w = 484 \text{ LB/IN}$$

$$= 5.8 \text{ K/FT} / 4\text{FT} = 1.452 \text{ K/FT}^2$$

$$1.3 \text{ K/FT}^2 \text{ (DL)}$$

$$.152 \text{ K/FT}^2$$

CHILDS ENGINEERING CORPORATION

Box 333
MEDFIELD, MA 02052

JOB PHILA 498-82

SHEET NO. 2

OF 3

CALCULATED BY CPS

DATE 2/16

CHECKED BY RGF

DATE 3/84

SCALE _____

IF A REVISION OF THE DL CALCULATIONS IS CONSIDERED -

PAVING	.33'	@ 125#/ft ³	=	41.25
EARTH FILL	9.17'	@ 120#/ft ³	=	1100.4
DECKING	.33'	@ 60#/ft ³	=	19.8
PILE CAP	.2'	@ 60#/ft ³	=	12
			DL =	1173.5 #/ft ²

USING A HORIZONTAL SHEAR STRESS OF 120 PSI THE

PILE CAP CAPACITY IS 1.1K/ft² AS SHOWN PREVIOUSLY

$$1.1K - 1,173 = -73 \text{ \# LIVE LOAD}$$

CHILDS ENGINEERING CORPORATION

Box 333
MEDFIELD, MA 02052

JOB 498-82-F PMSY

SHEET NO 1 OF 1

CALCULATED BY PATE DATE 2/21/84

CHECKED BY CDS DATE

SCALE NONE

REDUCED TIMBER PILE CAPACITY

(WHAFF L)



REDUCED CAPACITY

DUE TO TIMBER SOFTNESS

FROM AISC USE

ASSUME : $E = 1.6 \times 10^6 \text{ PSI}$
 $l = 16' = 192"$
 $K = .7$
 $A = 1.75 \text{ in}^2$

$$F_c' = \frac{3.619E}{(Kl/A)^2}$$

$$F_c' = .982 \text{ KSI}$$

$$F_c = (.982)(.9)$$

$$= .884 \text{ KSI}$$

$$P = F_c A$$

$$= (.884 \text{ KSI}) (38.5 \text{ in}^2)$$

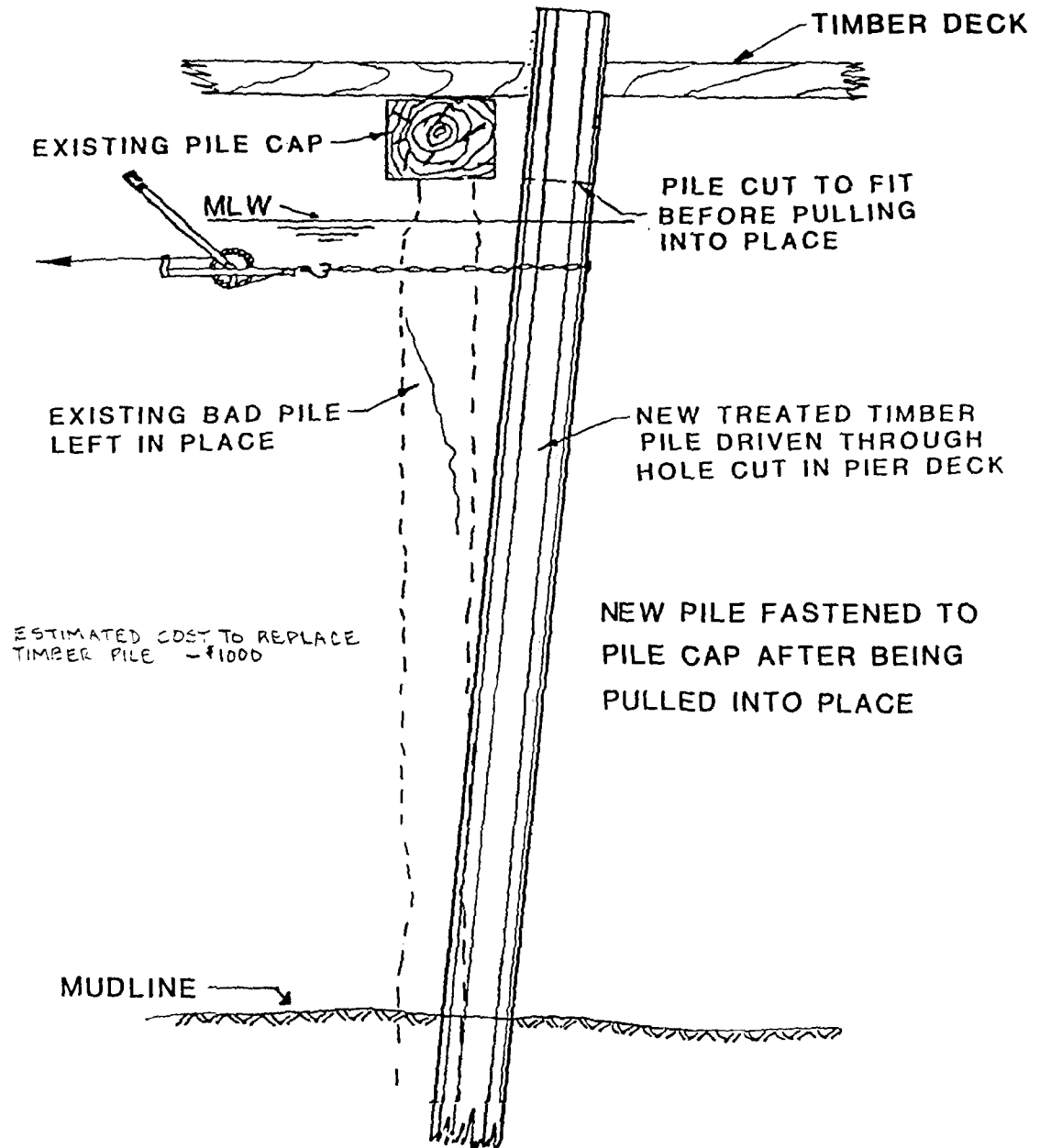
$$P = 34.0 \text{ K} = 17 \text{ T} > 15 \text{ T}$$

COLUMN CAPACITY GREATER THAN DRIVEN CAPACITY

\therefore DRIVEN CAPACITY IS LIMITING

REPLACEMENT TIMBER PILE

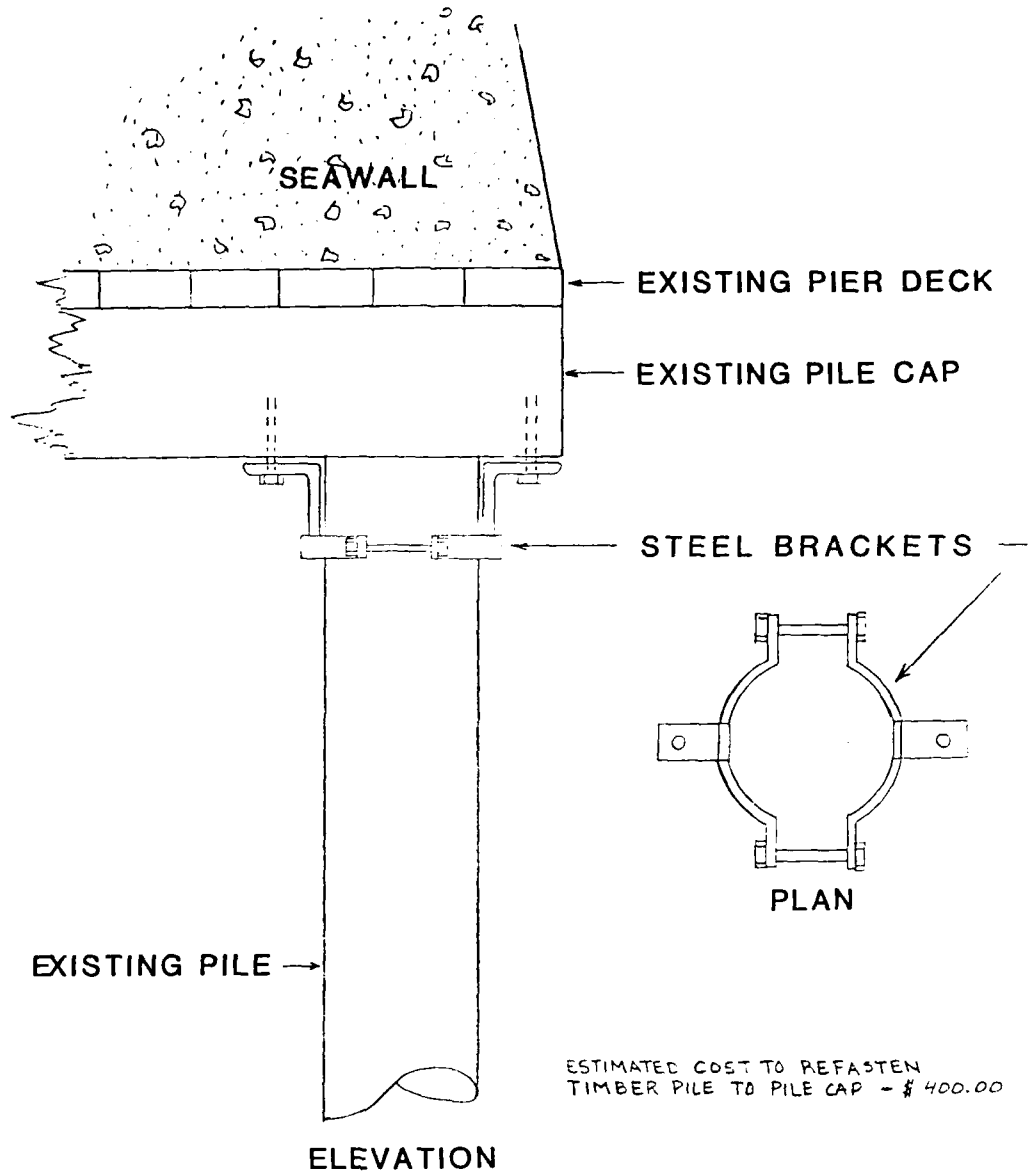
CONCEPTUAL DESIGN



GRAPHIC SCALE	CHILDS ENGINEERING CORPORATION BOX 233 MEDFIELD MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON D.C.	
NO SCALE		PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA PA	FIG NO
A-20		REPLACEMENT TIMBER PILE	A1

CONCEPTUAL DESIGN

REFASTEN TIMBER PILE TO PILE CAP

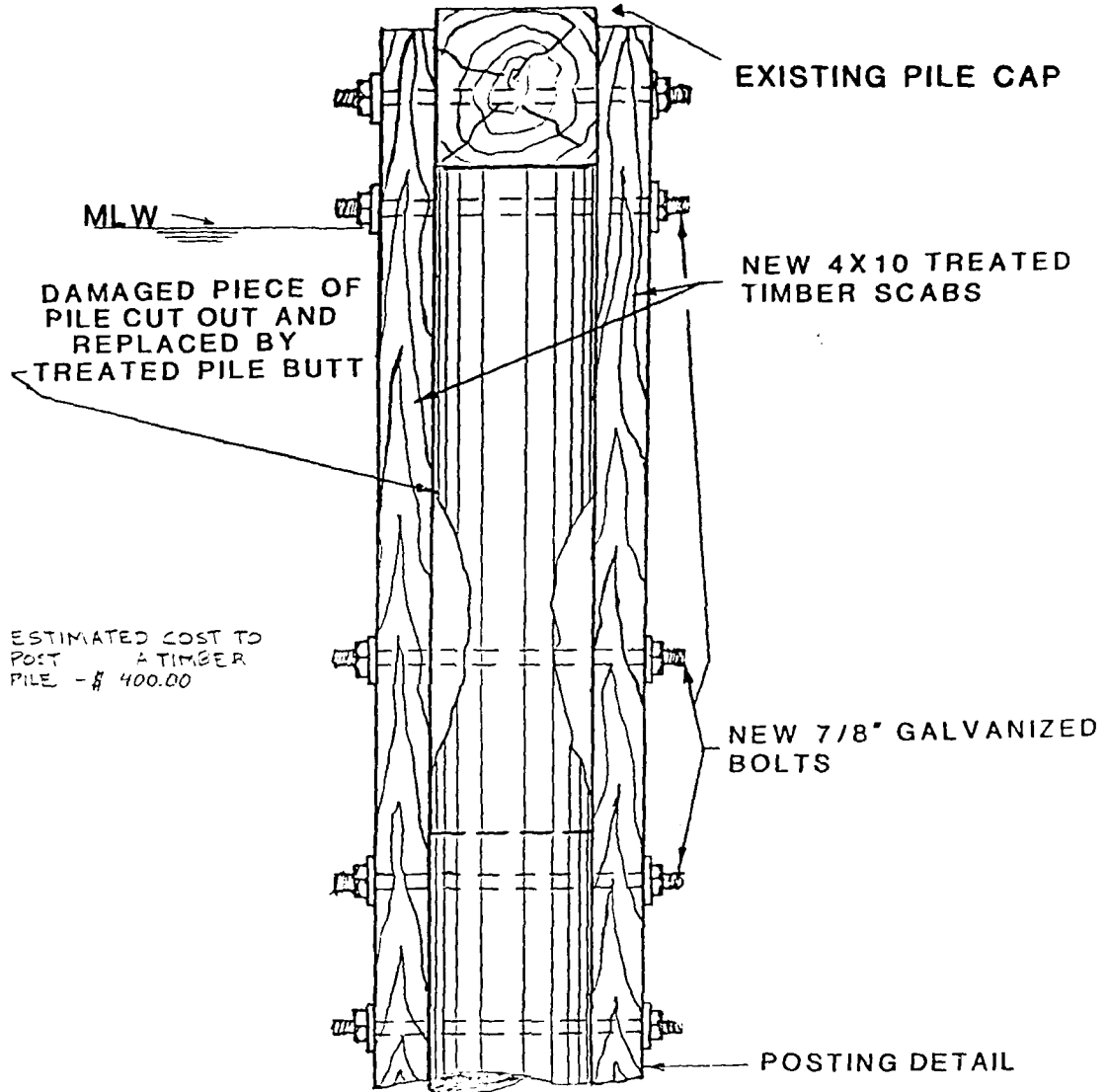


GRAPHIC SCALE	CHILDS ENGINEERING CORPORATION BOX 333 MEDFIELD MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON D C	
NO SCALE		PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA	TITLE CLAMP TIMBER PILE A2

A-21

POSTED TIMBER PILE

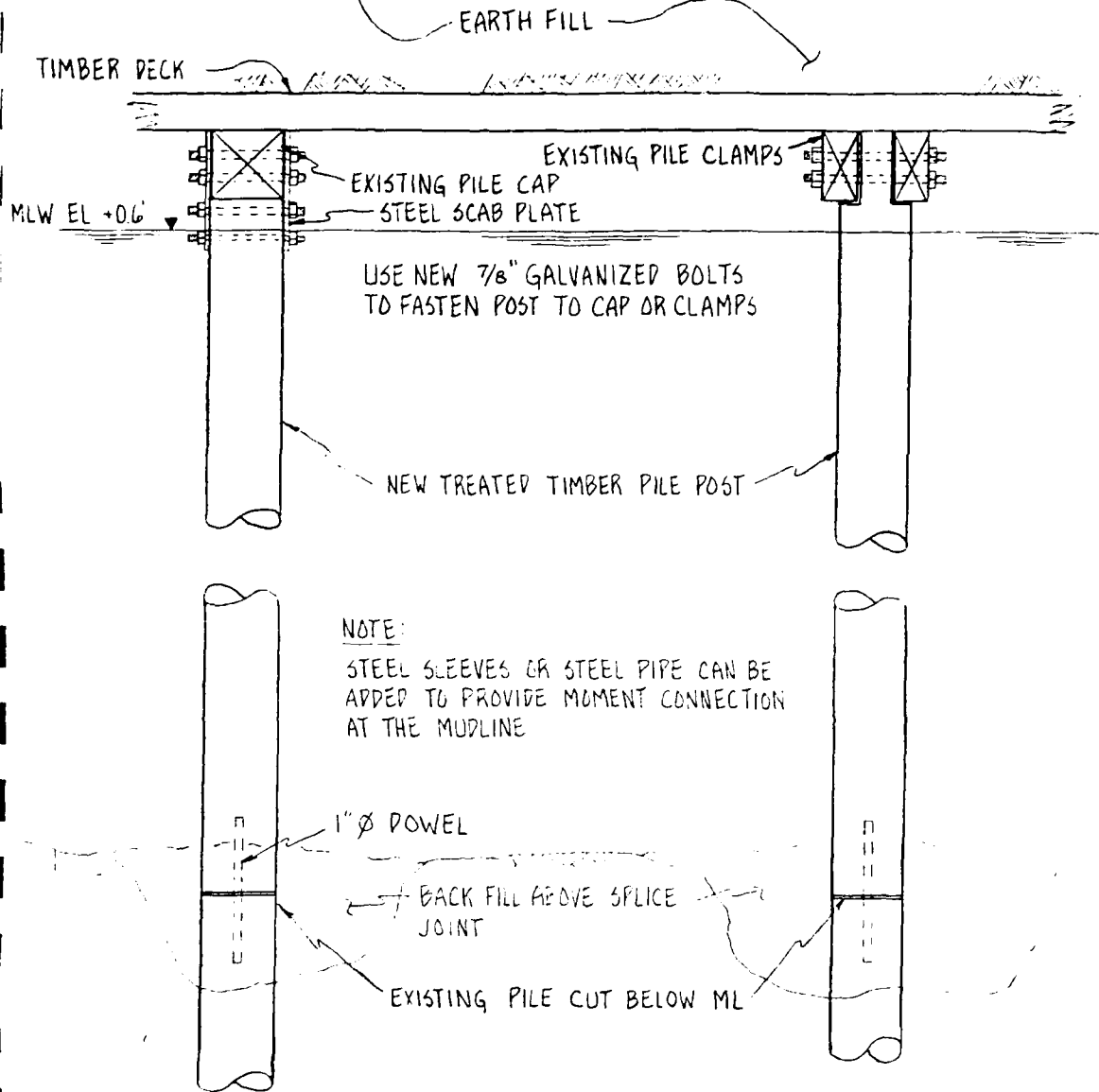
CONCEPTUAL DESIGN



GRAPHIC SCALE	CHILDS ENGINEERING CORPORATION BOX 333 MEDFORD MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON D.C. PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA PA	
NO SCALE		POSTED TIMBER PILE	A3

A-22

TIMBER PILE LONG POST CONCEPTUAL DESIGN



NOTE:

STEEL SLEEVES OR STEEL PIPE CAN BE
ADDED TO PROVIDE MOMENT CONNECTION
AT THE MUDLINE

1" Ø POWER

BACK FILL ABOVE SPLICE
JOINT

EXISTING PILE CUT BELOW ML

- NOTE:**
1. CROSS BRACING MUST BE USED BETWEEN ADJACENT LONG POSTS TO INSURE STABILITY IF THERE IS NO MOMENT CONN. AT THE ML
 2. ESTIMATED COST OF REPAIR IS \$1000 PER PILE

GRAPHIC SCALE

NO SCALE

CHILDS ENGINEERING
CORPORATION
BOX 333
MIDFIELD, MA

A-23

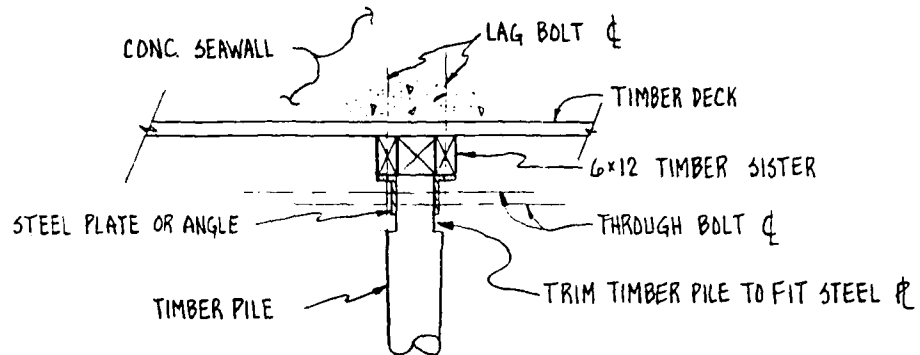
CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C.

PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA

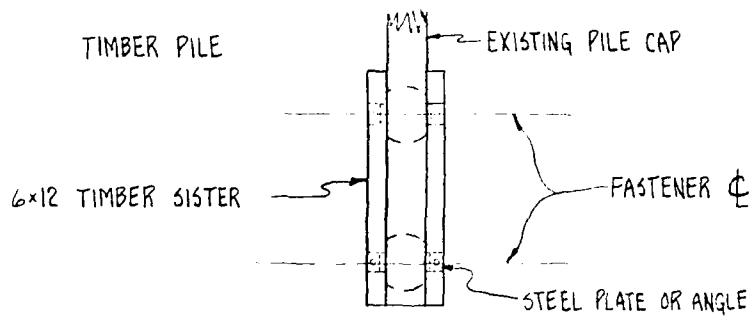
FIG. NO.

TIMBER PILE LONG POST

CONCEPTUAL DESIGN

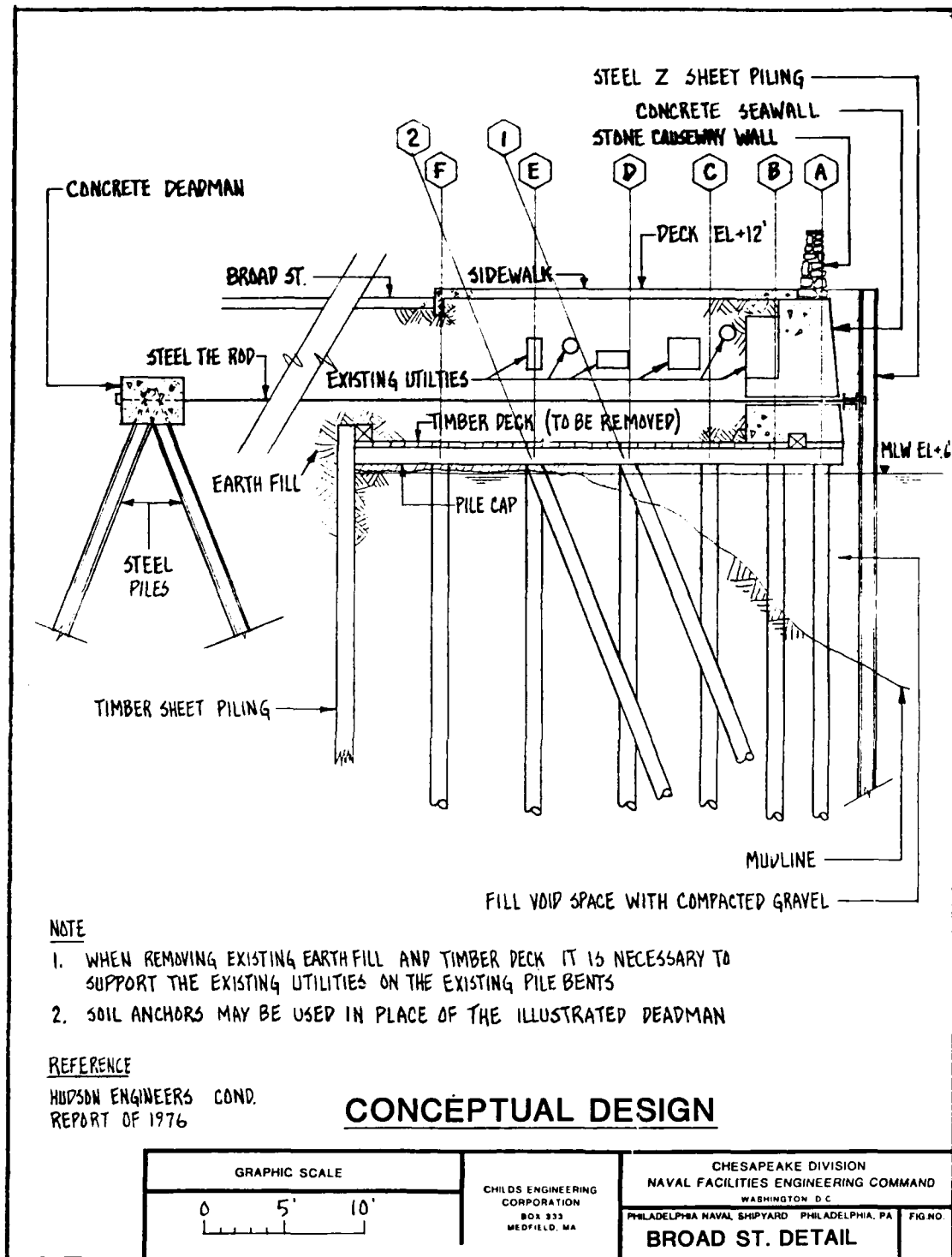


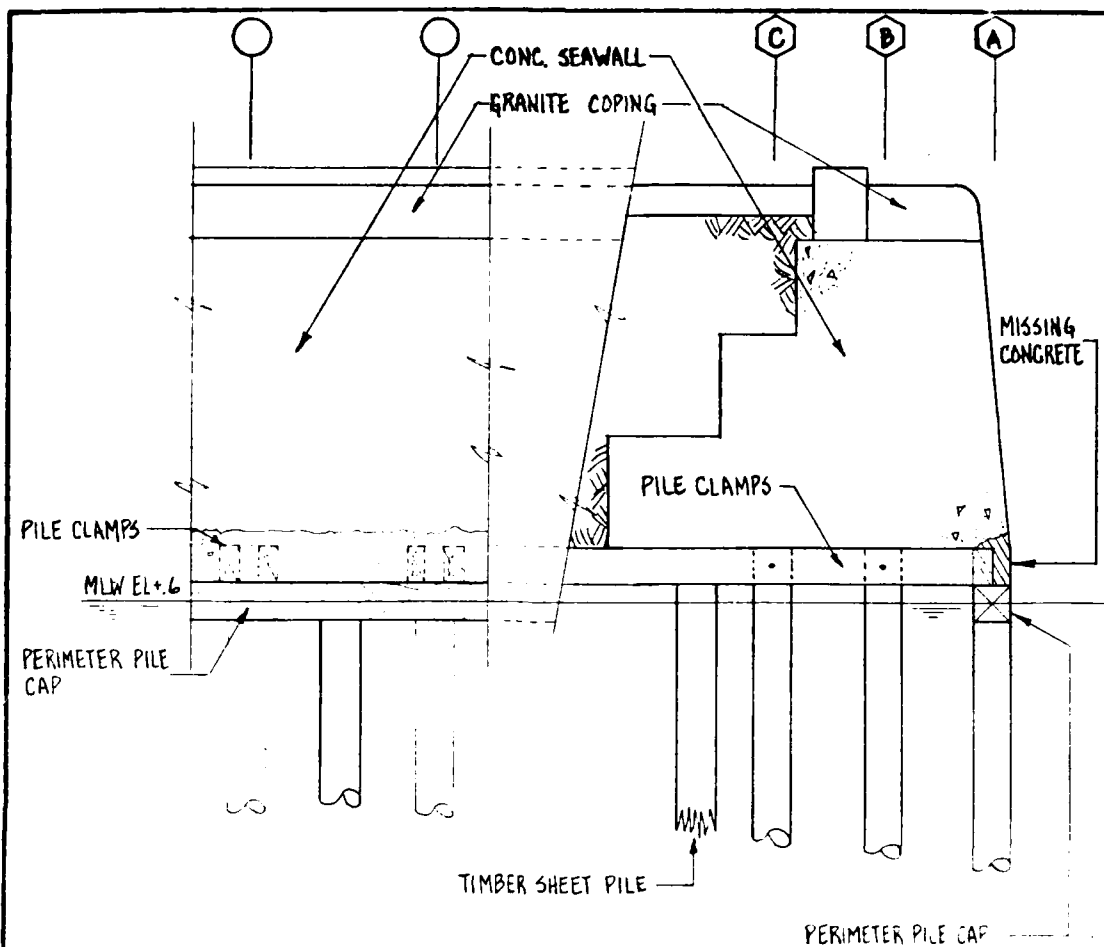
SECTION



PLAN

GRAPHIC SCALE	CHILDS ENGINEERING CORPORATION BOX 233 MEDFIELD, MA A-24	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON D.C. PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA PA	
NOT TO SCALE		FIG NO	PILE CAP SISTER





ELEVATION

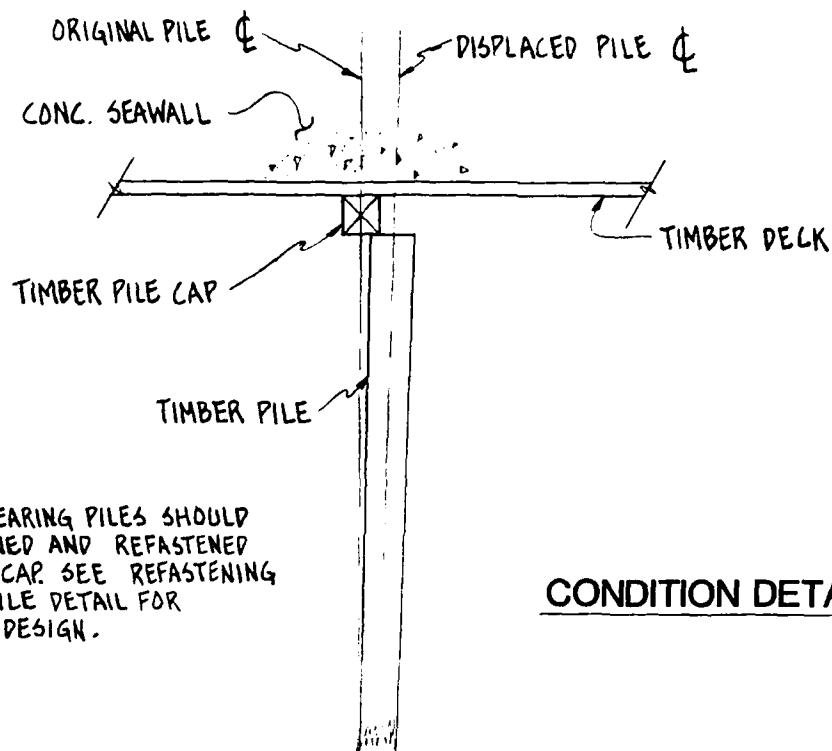
SECTION

NOTE: MISSING OR CRACKED CONCRETE GENERALLY OCCURS IN AREAS WHERE THE PERIMETER PILE CAP AND PERIMETER PILES ARE DAMAGED

CONDITION DETAIL

GRAPHIC SCALE	CHILDS ENGINEERING CORPORATION BOX 933 MEDFIELD, MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C.	
0 1 2 3 4 5 6 7 8		PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA SEAWALL DETAIL FIG NO	

A-26

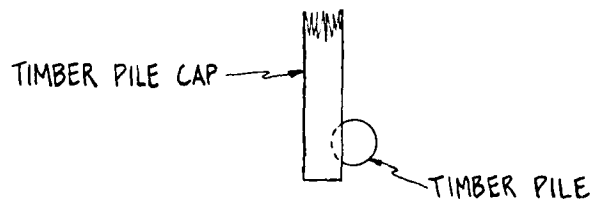


NOTE:

PARTIALLY BEARING PILES SHOULD BE REPOSITIONED AND REFASTENED TO THE PILE CAP. SEE REFASTENING OF TIMBER PILE DETAIL FOR CONCEPTUAL DESIGN.

CONDITION DETAIL

SECTION



PLAN

GRAPHIC SCALE	CHILDS ENGINEERING CORPORATION BOX 333 MEDFIELD, MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C.
1 0 1 2 3 4 5 6	A-27	PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA. FIG NO. PARTIALLY BEARING PILE

CHILDS ENGINEERING CORPORATION
Box 333
MEDFIELD, MA 02052

JOB _____
SHEET NO. 1 OF 1
CALCULATED BY CDS DATE _____
CHECKED BY _____ DATE _____
SCALE _____

- 1) REPLACEMENT PILE - UNIT COST \$1000 (IN PLACE)
2) PILE TOP REPAIR I.E. REFASTEN, SHORT POST, PILE CAP SISTER

ASSUME: CREW

1	FOREMAN	} \$1100 / DAY
2	DOCK BUILDERS	
1	LABORER	
1	DIVER	

AVERAGE LABOR COST PER REPAIR - 275

MATERIALS COST PER REPAIR - 125

Ave. Cost/REPAIR \$400

- 3) LONG POST REPAIR

CREW COST/DAY = \$1100 / DAY

CREW COST/REPAIR \$750

MATERIALS COST/REPAIR \$250

Ave COST/REPAIR \$1000

- 4) TIMBER SHEET PILE REPAIR

2 STEEL H-PILES IN PLACE (UNIT COST) \$2000

COST OF MISC. MATERIALS 500

COST OF LABOR 500

EST. TOTAL \$3000

NOTE: ① COSTS ARE BASED ON 1983 U.S. EAST COAST PRICES.
② COSTS DO NOT INCLUDE MOBILIZATION / DEMOBILIZATION

REFERENCES

1. Master Plan for Naval Base, Philadelphia, PA
August 1975
2. Divers Inspection, Engineering Evaluation and
Preliminary Recommendations for Piers and
Bulkheads at the Philadelphia Naval Shipyard,
Philadelphia, Pennsylvania; prepared by
Hudson Engineers, Inc., Philadelphia, PA
September 1976

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MR. CRAIG SAMS 359-8580

END

DATE
FILMED

7-86

DTIC